PROGRESS OF ATLAS AND POLARIS MISSILES

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HEARINGS

BEFORE THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS U.S. HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

FIRST SESSION

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PROGRESS OF ATLAS AND POLARIS MISSILES

TUESDAY, JULY 28, 1959

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met, pursuant to call, at 10 a.m., Hon. Overton Brooks (chairman of the committee) presiding.

The CHAIRMAN. The committee will come to order.

Gentlemen of the committee, we have convened the session this morning with the idea of looking into the progress being made in the missile program, especially the Atlas and other missiles involved in the program.

I have this short statement which I would like to read to the members and into the record.

We have been watching these programs with a great deal of interest and I know that all of the members of the committee are aware of the five successive failures of the latest Atlas test prior to a recent successful firing. In addition, we have been disturbed by the malfunction of the Polaris submarine-launched missile.

Now, at the outset I want to assure the armed services, and I am sure I speak for the committee, that we recognize that missiles, while still in the development stage, cannot be expected to fire successfully on each test. However, the Congress and the people of the Nation have been led to believe that Atlas, for instance, was so far developed it was ready to be turned over to our troops for operational use. As a result of these unfortunate and successive malfunctions of the Atlas missile, the committee, the Congress, and many people throughout the Nation have become disturbed, because what they had considered to be an operational retaliatory weapon has failed many times in recent tests.

Before these hearings begin I want to make one matter crystal clear. The committee is not attempting to poach on the jurisdiction of any other committee. The Atlas is not only a military vehicle, but also is a vehicle which lends itself to peacetime use. Eventually, it will be placed in operational use in the armed services, but it has a dual purpose in that it will be a booster which will be used by NASA for the man-in-space program.

As a consequence, this committee has a responsibility to search out the facts and determine wherever possible the cause of recent flight test failures and what is being done to correct these failures. Actually, we are as much concerned with the effect that these failures may have on the man-in-space program as the effect on the vehicle's operational use in the armed services.

So long, however, as the Atlas and the Polaris missiles continue in a research phase, I believe this committee has the duty to follow up on the successes or failures.

In this connection I thought the committee would be interested to know that there is $7 million for the Atlas boosters in the NASA's 1959 supplemental budget, and $13½ million in its 1960 budget. We must attempt to determine how much, if any, these unsuccessful tests have delayed the man-in-space program and whether NASA will be compelled to come back to Congress for additional funds for continuing tests.

There have been certain charges leveled against our space programs to the effect that there was a duplication of effort in some programs. We hope that this is not the fact and any failure of progress cannot be attributed to this. Rather, we are hopeful that the witnesses who appear before us during these hearings will be able to give the committee the reasons for successive testing failures and what steps are being taken to correct these failures.

The committee is not conducting these hearings with the intent of criticizing the Air Force, the Navy, or anybody else. We are not here merely to find fault, but rather to get to the bottom of our missile testing difficulties in an attempt to be of assistance to our country.

I think that covers the matter.

This morning we have the pleasure of having Lt. Gen. Bernard A. Schriever, Air Research and Development Command, U.S. Air Force, before us.

Mr. Fulton wants to make a short comment.

Mr. FULTON. I am glad to have General Schriever here, and we have full confidence in the Air Force. Some of us who have followed your programs have been well pleased with your progress. This is in the nature of finding and maybe having a way in which we might be able to help, and for your statements of progress I think you will find a ready reception in this committee.

The CHAIRMAN. We are certainly happy to have the general with us. Now, General, you have a prepared statement. Would you please proceed with the statement, sir.

STATEMENT OF LT. GEN. BERNARD A. SCHRIEVER, AIR RESEARCH AND DEVELOPMENT COMMAND, U.S. AIR FORCE, ACCOMPANIED BY COLONEL CRISTADORO, PROGRAM DIRECTOR, ATLAS PROGRAM, AND COLONEL BOATMAN, ASSISTANT TO LIEUTENANT GENERAL SCHRIEVER

General SCHRIEVER. Yes, sir; I do. I would like to say I have Colonel Cristadoro here with me, who is the program director for the Atlas program, and Colonel Boatman, who has been my valuable assistant for a good many years in the ballistic missile program, to assist me in any detailed questions that might arise.

I would like to proceed with my prepared statement.

The CHAIRMAN. Fine.

General SCHRIEVER. Mr. Chairman and members of the committee, I sincerely welcome this opportunity to discuss with you the problems which have recently been encountered in the Atlas flight test program. In my opinion, it is an extremely healthy indication that so many re-

sponsible Americans are concerned about the status of this ICBM program, for no other weapon system under development today is more important to our national security during the early 1960's. I can positively assure you that no one is more concerned than those whose responsibility it is to accomplish the successful development and earliest possible deployment of the Atlas weapon system.

There is nothing new in the keen sense of urgency we have felt as we have sought the solutions to the problems which have recently been encountered in the Atlas flight test program. In fact, the urgent nature of the race with the Soviets was clearly defined by Dr. John Von Neumann in the report of his Strategic Missiles Evaluation Committee in February 1954.

A strong sense of urgency was again clearly demonstrated when the Air Force gave the ICBM program No. 1 priority in March of 1954, months before a management organization could be established to reorient and direct the development of the Atlas. Again, in September 1955, this unprecedented emphasis was reflected by National Security Council action which assigned top national priority to the Atlas program.

Today, by visiting merely a few of the many diversified activities which we are pressing forward concurrently in order to provide the earliest possible ICBM operational capability, one quickly realizes that a real sense of urgency is by no means confined to the top planning and management echelons—it also motivates tens of thousands of scientists, engineers, industrial workers, and military personnel at lower management and working levels throughout the Nation.

The round-the-clock efforts which have been devoted to solving the recent Atlas flight test difficulties are to me reminiscent of a period only 2 years ago, when the Atlas first entered its flight test phase. You will recall that at that time we were faced with problems which were of a similar magnitude. As we analyzed and solved these problems, it was necessary to readjust individual flight test schedules, but this had no significant effect upon overall program plans. You also will recall that we then had far less experience and engineering data on which to base our diagnoses.

Returning to the problems of today, it is, of course, too early for me to say with certainty that we have identified and eliminated the causes of our recent Atlas flight test malfunctions. I can say though that we are exerting every possible effort to make certain that we have done so. I am confident of success.

As of today it appears that we will overshoot our longstanding target date for the first operational capability at Vandenberg Air Force Base by at least 60 days. However, I believe as we go down the road that we will be able to adhere very closely to the overall Atlas operational force buildup schedule.

So that this committee and the American public may also have as sound a basis as possible for independent evaluation of the Atlas program, I will now summarize, to the extent permitted by security considerations, the actual malfunction occurrences. I am prepared to go into greater detail in executive sesesion if the committee so desires.

First, I would like to point out the five malfunctioning Atlas test missiles since February 4, 1959, which have caused us grave concern. All were on series C and series D missiles. The last B series missile

fired on February 4, 1959 was completely successful. You may recall that the B series Atlas was the first to incorporate the sustainer engine. By this very successful series of flight tests we confirmed the fundamental objectives of the development program; that is, the design adequacy of structure, propulsion, staging, guidance, nose cone separation, and propellant utilization.

The five malfunctioning missiles to which I have referred are:

No. 5C, launched February 20,
No. 7C, launched March 18,
No. 3D, launched April 14,
No. 7D, launched May 18, and
No. 5D, launched June 6.

Our evaluation of the malfunctions which occurred to missile 7C, 3D, and 7D clearly established that these malfunctions were not related, were readily identifiable, and have been corrected. The explosion of missiles 5C and 5D, the first and last of the problem group, appeared to have been related. Both missiles exploded shortly after staging. In other words, they went through staging and the explosion occurred after separation of the skirt and booster engines.

It should be noted, however, that missile 5C had been preceded by the extremely successful and accurate flight of the first C series Atlas launched on December 23, 1958, and then by a second C series Atlas on January 27, 1959 which achieved a major portion of its objectives.

Intensive analysis narrowed down the possible causes of the explosions which have been applied to the Atlas missiles currently being tested. I will be happy to outline the details in executive session.

Atlas 8C, which flew with complete success Monday of last week, incorporated these modifications and was specially instrumented in the suspect area. Excellent telemetry data provide no indication of any problems on that missile. All future missiles also will be similarly modified.

This brief summary of the recent Atlas malfunctions accentuates the fundamental reason for a flight test program. Only through flight testing can we identify and correct those engineering and procedural weaknesses which could lessen the operational effectiveness of the weapon system.

It may assist the committee's evaluation of this situation to know that in mid-June, as in many previous instances of concern regarding our development progress, we called an eminent panel of the Air Force Scientific Advisory Committee into consultation to assist us in our analysis of these failures. The following excerpts are from their findings:

After a detailed study of the entire Atlas flight test history, the group strongly affirms its conviction that the overall record gives confidence in the attainment of the original objectives, and that the recent failures are of the type and severity which must be expected in any such advanced and far-reaching development program * * *. The group feels it is important to avoid being stampeded into major changes in any missile test program because of press and public reaction to so-called failures and wishes to emphasize again that failures must be expected as a part of such a test program. There is a point beyond which the attempt to reduce test program failures would both delay and add to the cost of the overall development of the system.

I would like to emphasize that although the D series Atlas is the missile to be used in early operational squadrons, only three D missiles have been flown. The development program has always called for many more series D flight test missiles in order to improve performance and reliability while at the same time it is being introduced into the Atlas operational force. In other words, the development program and the operational program overlap by many months. This involves calculated risk but is the only means known to us to drastically compress the leadtime required to develop and operationally deploy this totally new weapon system.

My deep confidence in the Atlas program is not based solely on the flight test program. Flight tests are the spectacular result of a vast, orderly test program which begins long before in laboratories, on environmental test stands, on acceleration sled runs, on captive engine test stands, and finally on captive missile test stands. Early in the development program thousands upon thousands of tests are performed to demonstrate the adequacy of components, of subassemblies and then assemblies, of subsystems and then of systems, and finally of the entire missile. Valid estimates of ultimate missile reliability can only result from analysis of the sum total of all this testing data. Based on such analysis, we have good reason to believe that we will indeed achieve our operational reliability objectives. I am prepared to cover this in more detail in executive session.

In conclusion, and in order to place the Atlas program in the clearest possible perspective of a short 5 years of history, we must look at other aspects of the program. We are providing not only the operational missile but have also carried out many planning, management, and implementation activities essential to the operational capability. Concurrent, on-schedule provision has been made for trained personnel, for logistics and spare parts, for communications, for operational bases, and for a ground support environment of unprecedented complexity and magnitude. All of this is being done according to a very tight schedule which was established over 4 years ago. At the same time, we have been able to introduce highly significant improvements of later Atlas operational capabilities which were not even considered as we laid out those original schedules. I refer to such improvements as the all-inertial guidance, the ablation reentry vehicle, warheads of increased yield and hardening and dispersal of launch sites.

Mr. Chairman, while we have had our troubles in the past and may expect more in the future, I believe this country has no cause for alarm regarding the current status of the Atlas program, but does indeed have great cause for a continued sense of urgency as we press forward toward attainment of our ultimate development and operational goals.

Now, I would like to make a few further comments, Mr. Chairman, that deal with my prepared statement. If you will permit me, I would like to read one paragraph from the original Von Neumann Committee report, which was submitted to the Air Force in 1954, and I think this is a pertinent paragraph:

> The committee sees no technical reason why, by such procedure, assuming proper direction and support—

and I might say they are now talking about a management organization and highest priority given to the program—

that a period of 6 to 8 years should not permit the attainment of the beginnings of an operational capability.

So they considered at that time that with the very best of support from a management standpoint, from a priority standpoint, that 6 to 8 years would be required to have the beginnings of an operational capability.

Mr. MILLER. What was the date of that report, General?

General SCHRIEVER. This was in February 1954.

Mr. MILLER. Seven years would be 1961 that you would reach that objective, that anticipated objective?

General SCHRIEVER. That is right. Now, there is one other thing to show you how fast these things move. I appeared before this committee in February, February 3, and I made the following statement:

"In the Atlas program we have had about 75 percent success." Now, I might say that was about the time we completed the "B" series flights and had made one "C" series flight which was successful. Of 12 flights we had 8 completely successful flights of complete staging; in other words, of the complete missile, staging, guidance, and so forth. So at that particular point in time you can see that I was pretty optimistic about how we were doing. I said "which has been phenomenally good." In the Thor it has been running between 50 and 60 percent. You would think with a single stage engine you would do somewhat better than that, but the Atlas has been actually a little better in its test program from a reliability standpoint than the Thor. Well, the Thor, subsequent to this statement of mine, reeled off 16 successful flights in a row. So you never know what happens in these programs. The Atlas proceeded to reel off five unsuccessful flight in a row. So these are the problems that we run into in the test programs for these types of missiles.

I might say that we have been proceeding right on schedule in all of the other phases of the Atlas program—the establishment of the operational environment, the training of personnel, the production of missiles. Assuming that we have found the fix on the Atlas, and we have a rather accelerated flight test program during the next 5 weeks which will determine for sure whether we have, then we should have the beginnings of our operational capability about 60 days behind what we had originally hoped for.

I might point out that this program has always been a high-risk program. We have never claimed a reliability of more than about 50 percent at the initiation of the operational capability. I have hopes that maybe we will have a little better than a 50 percent reliability. We think that inherent in the missile is a reliability in the order of 80 percent, perhaps a little higher. So these are some of the background factors that relate to the Atlas program.

I would be very glad to answer any questions that you might have now.

The CHAIRMAN. Thank you very much, General.

General, we are going to intrude on your time just a little bit now.

The other day when we met we had a little difficulty obtaining a quorum—we lacked one man of having a quorum; this late in the ses-

sion it is difficult. This morning I am delighted to say that we have amply a quorum. At that time we took up, as a committee, H.R. 8284, a bill to amend the National Science Foundation Act of 1950.

(The bill referred to is as follows:)

[H.R. 8284, 86th Cong., 1st sess.]

A BILL To amend the National Science Foundation Act of 1950, as amended, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Science Foundation Act of 1950, as amended, is amended as follows: Section 3(a)(2) of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

"(2) To initiate and support basic scientific research and programs to strengthen scientific research potential in the mathematical, physical, medical, biological, engineering, and other sciences, by making contracts or other arrangements (including grants, loans, and other forms of assistance) to support such scientific activities and to appraise the impact of research upon industrial development and upon the general welfare;".

SEC. 2. Section 4(d) and section 4(e) of the National Science Foundation Act of 1950, as amended, are amended to read as follows:

"(d) The Board shall meet annually on the third Monday in May, unless, prior to May 10 in any year, the Chairman has set the annual meeting for a day in May, other than the third Monday, and at such other times as the Chairman may determine, but he shall also call a meeting whenever one-third of the members so request in writing. A majority of the voting members of the Board shall constitute a quorum. Each member shall be given notice, by registered mail mailed to his last known address of record not less than fifteen days prior to any meeting, of the call of such meeting.

"(e) An election of the Chairman and Vice Chairman of the Board shall take place at the first meeting of the National Science Board following enactment of this legislation. Thereafter such election shall take place at the second annual meeting occurring after each such election. The Vice Chairman shall perform the duties of the Chairman in his absence. In case a vacancy occurs in the chairmanship or vice chairmanship, the Board shall elect a member to fill such vacancy."

SEC. 3. Section 5(b) of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

"(b) In addition to the powers and duties specifically vested in him by this Act, the Director shall, in accordance with the policies established by the Board, exercise the powers granted by sections 10 and 11 of this Act, together with such other powers and duties as may be delegated to him by the Board; but no final action shall be taken by the Director in the exercise of any power granted by section 10 or 11(c) unless in each instance the Board has reviewed and approved the action proposed to be taken, or such action is taken pursuant to the terms of a delegation of authority from the Board or the Executive Committee to the Director."

SEC. 4. Section 6(a) and section 6(b)(1) of the National Science Foundation Act of 1950, as amended, are amended to read as follows:

"(a) The Board is authorized to appoint from among its members an Executive Committee, and to assign to the Executive Committee such of the powers and functions granted to the Board by this Act as it deems appropriate; except that the Board may not assign to the Executive Committee the function of establishing policies.

"(b) If an Executive Committee is established by the Board—

"(1) such Committee shall consist of the Director, as a nonvoting ex officio member, and not less than five nor more than nine other members elected by the Board from among their number."

SEC. 5. Section 10 of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

"(a) The Foundation is authorized to award, within the limits of funds made available specifically for such purpose pursuant to section 17, scholarships and graduate fellowships for scientific study or scientific work in the mathematical, physical, medical, biological, engineering, and other sciences at appropriate

nonprofit American or nonprofit foreign institutions selected by the recipient of such aid, for stated periods of time. Persons shall be selected for such scholarships and fellowships from among citizens of the United States, and such selections shall be made solely on the basis of ability; but in any case in which two or more applicants for scholarships or fellowships, as the case may be, are deemed by the Foundation to be possessed of substantially equal ability, and there are not sufficient scholarships or fellowships, as the case may be, available to grant one to each of such applicants, the available scholarship or scholarships or fellowship or fellowships shall be awarded to the applicants in such manner as will tend to result in a wide distribution of scholarships and fellowships among the States, Territories, possessions, and the District of Columbia."

SEC. 6. Section 11(e) of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

"(e) to acquire by purchase, lease, loan, gift, or condemnation, and to hold and dispose of by grant, sale, lease, or loan, real and personal property of all kinds necessary for, or resulting from, the exercise of authority granted by this Act."

SEC. 7. Section 13 of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

"(a) The Foundation is hereby authorized to cooperate in any international scientific activities consistent with the purposes of this Act and to expend for such international scientific activities such sums within the limit of appropriated funds as the Foundation may deem desirable. The Director, with the approval of the Board, may defray the expenses of representatives of Government agencies and other organizations and of individual scientists to accredited international scientific congresses and meetings whenever he deems it necessary in the promotion of the objectives of this Act. In this connection, with the approval of the Secretary of State, the Foundation may undertake programs granting scholarships and fellowships to, or making other similar arrangements with, foreign nationals for scientific study or scientific work in the United States without regard to section 10 or the affidavit of allegiance to the United States required by section 16(d)(2) of this Act.

"(b)(1) The authority to enter into contracts or other arrangements with organizations or individuals in foreign countries and with agencies of foreign countries, as provided in section 11(c), and the authority to cooperate in international scientific activities as provided in subsection (a) of this section, shall be exercised only with the approval of the Secretary of State, to the end that such authority shall be exercised in such manner as is consistent with the foreign policy objectives of the United States.

"(2) If, in the exercise of the authority referred to in paragraph (1) of this subsection, negotiation with foreign countries or agencies thereof becomes necessary, such negotiation shall be carried on by the Secretary of State in consultation with the Director."

SEC. 8. Section 15(d) of the National Science Foundation Act of 1950, as amended, is amended to read as follows:

"(d) The members of the Board, and the members of each divisional committee, or special commission, shall receive compensation at the rate of $50 for each day engaged in the business of the Foundation pursuant to authorization of the Foundation and shall be allowed travel expenses as authorized by section 5 of the Act of August 2, 1946 (5 U.S.C. 73b–2)."

The CHAIRMAN. Now, we reported it out. But, it has been called to my attention that we lacked one of having a quorum. Therefore, I think that the motion having already been made and duly seconded, that this commitee should affirm the action of the preceding committee; in other words, pass the bill this morning.

Mr. FULTON. Mr. Chairman, I believe that under the rules we should have a new motion to report out.

Mr. MILLER. I make such a motion.

Mr. ANFUSO. I second it.

The CHAIRMAN. You have heard the motion. It has been duly seconded.

Now, that has the amendment in it, Mr. Ducander?

Mr. DUCANDER. Yes, sir.

The CHAIRMAN. All right, all in favor of H.R. 8284 make known by saying "Aye."

Mr. FULTON. May I ask for a rollcall, please?

The CHAIRMAN. A rollcall has been requested. Mr. Finch, will you call the roll.

(Rollcall.)

Mr. FINCH. Mr. Chairman, the count is 15 ayes.

The CHAIRMAN. How many nays?

Mr. FINCH. None.

The CHAIRMAN. No nays. The bill is unanimously reported to the House.

Mr. MILLER. I assume, Mr. Chairman, that my motion carried with it the instruction to take such steps necessary as to secure the passage of the bill.

The CHAIRMAN. I assume so. We will need the support of the Members on both sides.

Mr. FULTON. A point of inquiry. Would that mean to have it possibly put on the Consent Calendar or to have it passed——

The CHAIRMAN. It would seem to me that it could go on the Consent Calendar and I doubt that there would be any serious opposition to it. If there is opposition, then we would ask probably for suspension of the rules.

Mr. FULTON. Then would you have within that motion that we recommend that the chairman first proceed to put it on the Consent Calendar?

Mr. MILLER. Would the gentleman yield? I think my motion is standard practice. You leave that to the discretion of the chairman. It says that he take such steps to see that the bill is enacted.

The CHAIRMAN. If there is no objection, it is so ordered.

Now, H.R. 8374, which is the bill to amend Public Law 85–880, was amended by the committee. We took no vote on that, and I will entertain at this time a motion to report the bill favorably.

(The bill referred to is as follows:)

[H.R. 8374, 86th Cong., 1st sess.]

A BILL To amend Public Law 85–880, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the first sentence of section 1 of the Act of September 2, 1958 (Public Law 85–880; 72 Stat. 1703) is hereby amended as follows:

(a) After the phrase, "World Sciences—Pan Pacific Exposition", insert "now known as Century 21 Exposition".

(b) Strike out "1961" and insert in lieu thereof "1961 and 1962".

SEC. 2. (a) Clause 5 of section 3 of said Act is hereby amended to read as follows:

"(5) incur such other expenses as may be necessary to carry out the purposes of this Act, including but not limited to expenditures involved in the selection, purchase, rental, construction, and other acquisition of exhibits and materials and equipment therefor and the actual display thereof, and including but not limited to related expenditures for cost of transportation, insurance, installation, safekeeping, maintenance and operation, rental of space and dismantling; and."

(b) Add clause 7 to section 3 of said Act as follows:

"(7) procure services as authorized by the Act of August 2, 1946 (5 U.S.C. 55a), but at rates for individuals not to exceed $50 per diem."

SEC. 3. That part of clause 3 of section 3 of said Act before the proviso is hereby amended to read as follows:

"(3) erect such buildings and other structures as may be necessary for United States participation in the exposition, on land conveyed to the United States free of liens and encumbrances or leased to the United States for a period of not less than 20 years, whichever may be determined by the United States to be in its best interests (in consideration of the participation by the United States in the exposition, and without further consideration other than that of continued use for public purposes), by the State of Washington or by any local government of such State or any political subdivision or instrumentality of either."

SEC. 4. Section 6 of said Act is hereby amended to read as follows:

"SEC. 6. After the close of the exposition, all property, real and personal, acquired or received pursuant to section 3 hereof and all property purchased or erected with funds provided pursuant to this Act shall be utilized and disposed of in accordance with the Federal Property and Administrative Services Act of 1949, as amended (40 U.S.C. 471), and other applicable Federal laws relating to the disposition of excess and surplus property."

SEC. 5. Section 7 of said Act is hereby repealed and in lieu thereof add a new section 7 and a new section 8 to said Act, all reading as follows:

"SEC. 7. There is hereby authorized to be appropriated, to remain available until expended, not to exceed $12,500,000 to carry out the provisions of this Act, including participation in the exposition.

"SEC. 8. The functions authorized in this Act may be performed without regard to the prohibitions and limitations of section 3735, Revised Statutes (41 U.S.C. 13)."

Mr. MILLER. I so move.

Mr. ANFUSO. I second the motion.

Mr. WOLF. Is it possible there will be a minority report, or minority views on that?

The CHAIRMAN. Any member always has the right to file a minority report on anything he wishes. The Chair will say, however, that the purpose of the committee is to legislate, and we invite all of the support we can get from everyone.

Mr. FULTON. I ask for a rollcall.

The CHAIRMAN. A rollcall has been requested. All in favor of the passage of H.R. 8374, as amended by the committee, will make it known by saying "Aye."

Mr. DUCANDER. This is the clean bill, but it was amended by this committee and this incorporates the committee amendments.

The CHAIRMAN. Will you proceed with the rollcall.

(Rollcall.)

Mr. FINCH. Mr. Chairman, 13 ayes and 2 noes.

The CHAIRMAN. Thirteen ayes, and two noes. The bill is passed.

Mr. MILLER. Mr. Chairman, at the time this bill was up for consideration, Mr. McCormack and Mr. Sisk, having to leave, gave me their proxies and I ask, although those proxies technically were dated that day, they gave me the privilege of voting them.

I ask unanimous consent that they be recorded.

Mr. HALL. I am not going to object. But those proxies were given on another bill.

Mr. MILLER. If you want to object, I will withdraw it.

Mr. HALL. No, I won't object, but those proxies were given on another bill. This is a new bill introduced only last Thursday.

Mr. MILLER. Now, Mr. Hall, you will admit you are talking about a technicality, because technically you can object and I will withdraw it.

The CHAIRMAN. Is there any objection to voting the two proxies?

Mr. HALL. No objection.

Mr. FULTON. Once the point has been raised, Mr. Chairman, this is a new bill, and unless the proxy is given on the new bill I think the gentleman has a valid point and they should not be counted.

The CHAIRMAN. Is there any objection to the voting of——

Mr. MILLER. I withdraw the request.

Mr. WOLF. Mr. Chairman, may I make a statement for the record?

The CHAIRMAN. Surely.

Mr. WOLF. I am not opposed to the idea of the United States participating, but I am opposed to the idea of the U.S. Government financing the construction of a building for the city of Seattle, and it is my impression that this is what is happening. I am informed that there is a building available that could be used for the U.S. exposition there and for this reason I have opposed the bill.

The CHAIRMAN. Well, the gentleman can make his views known at the proper time.

Mr. FULTON. Would you again renew your motion?

Mr. MILLER. No, I will not.

The CHAIRMAN. There were only two opposition votes.

Mr. HALL. I didn't mean to object.

Mr. MILLER. That is all right.

Mr. ANFUSO. Mr. Chairman, can we go on?

The CHAIRMAN. Mr. Moeller wishes to be excused.

Mr. ANFUSO. I would like to examine the witness.

The CHAIRMAN. All right, let's proceed.

I will say, since the gentleman has brought it up, that I doubt that this could be brought up on the consent calendar. It involves more than $1 million, and therefore we would either have to get a rule on it or suspension of the rules. I would like to consult with the leadership as to what they would recommend, and then I will consult with the members on the committee.

Mr. FULTON. I move that the chairman be so empowered.

Mr. MILLER. Seconded.

The CHAIRMAN. Any objection?

If not, so ordered.

Now, General, coming back—and thank you very much for the imposition on your time this morning by this committee—I want to ask you this: Of course, you refer to the Atlas and its operational possibilities. The Atlas is being built by the Air Force and by NASA, isn't it?

General SCHRIEVER. Well, the Atlas is a program directly under the Air Force alone.

The CHAIRMAN. It is under the Air Force alone, but it is being financed, isn't it, by NASA?

General SCHRIEVER. The Atlas program is being financed solely by the Air Force. However, when the Atlas is used as a booster for NASA flights, such as the Mercury, NASA pays for the booster.

The CHAIRMAN. We are seeking to appropriate $28 million to NASA for the payment of the work on the booster program.

General SCHRIEVER. Yes, sir.

The CHAIRMAN. Now, that would be the same Atlas that you are referring to as being operational, wouldn't it?

General SCHRIEVER. That is true. They will use the D series booster for their Mercury flight. There will, of course, be some modifications, but it is basically the same machine.

The CHAIRMAN. So that progress in one program is progress in the other program.

General SCHRIEVER. That is correct.

The CHAIRMAN. We are interested in both peacetime and military use, too.

General SCHRIEVER. Yes, sir.

The CHAIRMAN. In reference to the progress you are making, I am heartened by your optimistic views in reference to the future. Of course, I have been like other Americans and perhaps like yourself, disturbed by the five successive failures of this missile. Now, is there any particular difficulty which seems to run through the whole five series of failures that you could point out to us this morning in open session?

General SCHRIEVER. Well, as I pointed out in my statement, there were two failures that were definitely related. Three of them were unrelated, and I can generally point out what these three were and then take the two related ones. I think I can cover some of this within security grounds.

One of the failures occurred because we got a spurious signal from our guidance system which was, you might say, an electronic malfunction within the missile which caused the booster engines to shut down prior to the time they should have been shut down. This occurred about 30 seconds, as a matter of fact, prior to the shutdown as it was programed. What happens in that case is that the two booster engines on either side here [indicating], plus the little vernier engines, which you see on the side, are necessary for control of the missile, stability of the missile, during the first phase or first stage of its flight are no longer operating.

This engine here [indicating the center engine] is locked in place. It is called the sustainer engine. It can't move unless separation occurs. So what happened, when these engines shut down and separation did not occur, is that the missile went out of control. This engine [indicating the center engine] couldn't control during that phase. We actually, manually from the ground, caused separation to occur some 40 seconds later. By that time the missile was out of control. After the booster and skirt separated this engine then started to gimble. It tried to get the missile back under control, but couldn't.

Actually, on that particular flight, the sustainer engine burned until the normal time for burnout, but the missile did not impact anywhere near where we had intended.

The CHAIRMAN. In other words, the booster engine performed all right. The mistake was in the communication of signals to the ground?

General SCHRIEVER. No, the control system equipment in the missile gave a signal to the booster engines to shut down. Exactly how that occurred—it might have been a short, it might have been a failure—we never have been able to pinpoint. However, we do know exactly what happened. It was a malfunction of the electrical sys-

tem associated with the engine control system which occurred in flight.

The CHAIRMAN. In other words, the guidance system directed the engines to shut down too soon?

General SCHRIEVER. That is right.

The CHAIRMAN. It did not send a false signal to you on the ground?

General SCHRIEVER. No; it was in the missile.

The CHAIRMAN. So you had no way of knowing in advance the false signal was given?

General SCHRIEVER. We knew from the ground that the booster engines had been shut down; yes. We knew this immediately, because we have telemetry information which tells us exactly what is happening. We knew the booster engines had been shut down.

The CHAIRMAN. Is that the one where you had a duplicated failure?

General SCHRIEVER. No. I am giving you the three which were not duplicated. A second one occurred because of an open liquid oxygen fill and drain valve. This pipe right here [indicating] goes into the liquid oxygen tank, which is located in this portion of the missile [indicating]. There is a valve right here. At the point of liftoff, this valve was open. This was a personnel error, a procedure error, and liquid oxygen flowed from the tank out of this valve at a very high rate. This caused a very rapid drop of pressure in this tank, and also caused a fire in this section.

I have a picture on this which I can show you in executive session. This missile exploded about 30 seconds after liftoff due to this particular malfunction right here.

The CHAIRMAN. So that valve should have been closed, in which event where would the liquid oxygen have gone?

General SCHRIEVER. Well, you fill the missile from the ground through this point here, into this tank. Now, you see this elbow here. This should be closed when the missile is in flight, and all of the liquid oxygen coming out of the tank comes out through here, through this elbow into the engines.

The CHAIRMAN. It is recirculated; is that it?

General SCHRIEVER. Well, it is used up, it is burned through the engine.

The CHAIRMAN. So the valve being left open by mistake——

General SCHRIEVER. We were pumping the liquid oxygen overboard and we created a very hot fire, because the liquid oxygen just spilled out and this hot section here then was on fire. It didn't last very long.

The CHAIRMAN. Now, what effect did that have on the operation of the Atlas?

General SCHRIEVER. Well, it didn't operate very long.

The CHAIRMAN. That is No. 2. What about No. 3?

Mr. ANFUSO. Before you get to No. 3, will you explore that personnel error? I thought the general said it was a personnel error.

The CHAIRMAN. I thought we would sum them all up, first, and then go back over them in detail, each one.

Mr. ANFUSO. All right.

General SCHRIEVER. The third one which is unrelated had to do with these launch arms that you see on both sides. These are launcher holddowns. They are hydraulically operated.

The CHAIRMAN. General, is it possible for you to turn that model around a little bit. A lot of the members on this side can't see.

General SCHRIEVER. Well, I will turn it around. These are the arms, where I have my fingers, which hold the missile down. You have often read in the papers where we have had an automatic shutdown after a missile has been started. Well, these are the arms that hold the missile down.

We always want to be sure everything is functioning correctly before we release the missile. What happened in this particular case was one of the arms did not release properly at the time of lift-off. I also have pictures of that.

We found sheared bolts in the system which caused that. This pulled the skirt loose at this point right here. Behind this skirt there is a helium pressure system which keeps this missile under pressure during the flight. As you know, this is a balloon. It is a balloon structure, and you have to maintain relatively high pressure in the tanks. The helium pressurization system does that. It is located right behind that part of the skirt.

This part was pulled, separated by some 6 inches or so, and caused a rupture of our helium pressurization system. This in turn caused a drop in our pressurization in the tanks. The exact details of what happened after that I can't give. I can give that in executive session, but it caused a failure within the tank which caused the explosion.

Now, those three were unrelated in nature.

The CHAIRMAN. But the last one was due to the fact that there was a rupture of the helium pressurization system, and that resulted in the explosion and the premature destruction of the missile?

General SCHRIEVER. That is right.

Mr. MILLER. This was a mechanical failure not within the missile itself?

General SCHRIEVER. That is right.

Mr. MILLER. Do those two levers come out——

General SCHRIEVER. They come out hydraulically. The failure was in the launch equipment itself.

Mr. MILLER. Not in the missile?

General SCHRIEVER. Not in the missile. The other failure I pointed out was the separation where the valve remained open. It was a ground failure, not a missile failure.

The CHAIRMAN. The third one was a false signal?

General SCHRIEVER. Yes; an electronic failure.

Mr. MILLER. That was within the missile itself?

General SCHRIEVER. Yes.

Now, the two related failures occurred after staging. In other words, the missile had flown some 120 to 130 seconds during the first stage where all three engines operate. At staging the skirt and the two booster engines are released. Only the sustainer engine here and the little vernier engines, which you see on the side, continue to operate after staging. Both of these related failure occurred about 20 seconds after staging had occurred. In both instances the missile exploded.

These were related. They occurred on missile 5D and missile 5C. Actually, they were the first and the fifth of the five failures. We made a very detailed analysis of this, and we think that we have estab-

lished—we are certain we know where the problem area exists. We have made fixes and we highly instrumented the point where we felt that the problems were. Instrumenting and making these fixes is what caused a delay in our flight test program of some 5 or 6 weeks. We flew the first one with all fixes installed and instrumentation installed last Monday.

As I pointed out, we have quite an accelerated flight test program during the next 5 weeks which should once and for all determine whether or not we have got a solid fix on this particular problem area.

I can't go into this particular difficulty in detail in open session because it requires getting into certain basic structural and engineering aspects of the missile itself. I will have to discuss that in executive session.

The CHAIRMAN. Well, in general terms, what would you refer to it as?

General SCHRIEVER. Well, I can say this: We had a very severe fuel leak after separation. As a result of this severe fuel leak other things happened which then caused the missile to explode.

The CHAIRMAN. After separation, you mean after separation——

General SCHRIEVER. After separation of the first stage; in other words, the two booster engines and the skirt.

The CHAIRMAN. After the two booster engines and the skirt left the missile, there developed a very severe fuel leak?

General SCHRIEVER. Yes.

The CHAIRMAN. And that destroyed the missile prematurely?

General SCHRIEVER. The fuel leak occurred at separation. In other words, it was a malfunction at separation.

The CHAIRMAN. It was something that brought about the fuel leak at that particular time?

General SCHRIEVER. That is right. Now, remember we had never had this problem occur during the B series flights, and we had all of these separations during the B series occur. We had seven B series flights that went through separation. We did not have this malfunction occur on any one of those flights, nor did we have it occur on the first C series flights.

The CHAIRMAN. Could you tell me the difference between the B and the C series?

General SCHRIEVER. Yes, I can tell you briefly. There has been a slight change in the gage thickness of the tank to reduce the weight, and there has been a simplification of the engine compartment itself. The plumbing, not the basic engine was changed. The basic engine is exactly the same, but what I would call the plumbing has been simplified to a great extent in the D series.

The CHAIRMAN. And what about the difference between the C and the D; is that what you covered, because you referred to the D series?

General SCHRIEVER. Yes. The C has the same skin changes that the D has, but it did not have all of the changes in the engine compartment that the D had. The D is the first operational version, and it was simplified in the engine section. I think I can discuss the two related failures, perhaps, just a little bit more by—let me say the unrelated failures, a little bit more.

On this we have put an automatic device which prevents the missile from launching if the valve is not closed. We have put new, heavier,

stronger bolts in the launchers where we had the launcher malfunction. We also checked the bolts after each launch. We have redesigned the circuit in the engine control system where we suspect the trouble was, where we got the spurious signal. The C and D missiles are exactly the same, as far as the tank structure goes. The changes in the D are a simplification in the engine plumbing arrangements.

The CHAIRMAN. One more question and then I am going to recognize the other members. You state that you are 60 days behind schedule in your development of the Atlas. In other words, I would assume from that statement that you feel that 60 days from now you will be back on schedule in the work of developing the Atlas missile; is that right?

General SCHRIEVER. Well, let me say that we are 60 days behind. We had a target date, and we have had this target date for the last 3½ or 4 years, of having the initial operational capability on the 1st of July 1959. We had every reason to believe, after our successful B series tests, and the first couple of C flights, that we would be able to meet this, because everything else was going along on schedule—the construction of the facilities, the training program. Mind you, it was a very tight schedule, but everything was moving along concurrently.

The troubles that we ran into then on the C and D series made it mandatory for us to slip the date for the initial operational capability. You couldn't claim that you had a D series missile that was operational, when you had not yet had a successful test flight. The D series missiles are the missiles that are to be first operational. They are presently on the launchers at Vandenberg. The people are there, the facilities have been constructed, and we should, assuming that we are out of this development bind, have the first operational capability some 60 days after we had originally planned.

The CHAIRMAN. Well, are you operational as to NASA, too?

General SCHRIEVER. The NASA program, the Mercury program, their original flight was scheduled this month, July. This has been moved back 1 month, and it depends upon the success of our fix which I have just described to you.

The CHAIRMAN. Mr. Miller.

Mr. MILLER. General, could you tell us about the number of shots or missiles that you intend to fire in testing this missile, or should that be taken up in executive session?

General SCHRIEVER. Well, I won't give you the exact number, but I can tell you——

Mr. MILLER. Within a range.

General SCHRIEVER. That is what I will do. We have flown 26 Atlas'. To complete our test program—and remember, the test program is not only designed to prove out that the missile will do what you say it will do in accordance with its performance specifications, but also it is designed to give you reliability—we will launch more than 26 additional missiles. We have flown less than half of the total number of missiles that we will fly in our test flight test program.

Mr. MILLER. And out of that number you have these five failures?

General SCHRIEVER. Out of the 26 we have had the 5 failures that you mentioned, yes.

Mr. MILLER. So we are less than halfway there and we have had five failures; that isn't a great percentage of failures?

General SCHRIEVER. We have had more failures than that. We have had more than 5 in the total of the 26 that we fired. We have had 11 completely successful flights out of the 26.

Mr. MILLER. Now, it is anticipated, as you go along, though, that the failures will become less?

General SCHRIEVER. That is our whole philosophy.

Mr. MILLER. That is your hope?

General SCHRIEVER. This is the way historically the pattern has always run.

Mr. MILLER. So in a program of this kind, when you started this program, although it was the consummation devoutly to be wished that every one would go off perfectly, as a matter of practical fact, you anticipated that you were going to have a number of failures. You wouldn't be testing if you didn't expect these failures?

General SCHRIEVER. That is true.

Mr. MILLER. The failures here, then, haven't been any greater than perhaps you had anticipated at the time that you went into the program?

General SCHRIEVER. Well, as a matter of fact, the failures have been less than I anticipated 4 years ago. I can tell you that very honestly, and when we had the success in the B series flights which we had, it took me completely by surprise. As a matter of fact, it perhaps made us a little overconfident, but I would say that our failure rate on flight tests has not been as great as we had anticipated earlier.

Mr. MILLER. Mr. Chairman, I think that some of us become a little impatient, and the American people generally, I think, say: "Well, these things shouldn't happen." But after all, we are delving into a new realm and you expect certain failures. I think that these failures are not greater than those anticipated and we haven't got too much to worry about. I think we have made great strides, and I congratulate General Schriever.

General SCHRIEVER. I can assure you when we have five failures in a row we are the most unhappy group of people in the world.

Mr. MILLER. You are in the same position as Congress when it has to raise taxes.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. Of course, the problem comes up of the effect on Congress and the American people of these flights. The real test is: Has it discouraged any of our seven astronauts? What do they feel about it? They are the ones that are going to have to ride these things. Have anyone of them said that it is not the vehicle for him? Have they expressed any doubts as to the Atlas as a booster for the Mercury program?

General SCHRIEVER. I have not talked to them myself so I don't know. But, of course, their timetable is such that I think that we will have a much more reliable missile than we have today by the time one of them gets on the end of it.

Mr. FULTON. Were there an explosion just off the pad at a time when these particular explosions have occurred, the astronaut or Mercury man will be safe and will be able to eject himself from the missile; is that not right?

General SCHRIEVER. That is right. The plan calls for the safety of the astronaut under any conditions that might occur. In other

words, failure at any point, failure on the launch pad, right on through any other point of the trajectory.

Mr. FULTON. Now, in order to determine what the test is for operational flight, how many flights must be successful out of what total, so that we can then say that the Atlas vehicle is operational? What is your test on that?

General SCHRIEVER. Well, we haven't really based it on a statistical count. I think that we certainly will not have the opportunity to fire enough in the next few months to get a true statistical analysis in terms of what the reliability is. We feel that if we can get several "D" series off in the next 5 or 6 weeks, that based on the total flights that we have had, that we can consider the "D" series as being operational with a reliability perhaps on the order of 50 percent, perhaps a little bit more, but this is a matter of judgment.

I think that we will not know statistically where we stand until *toward the end of the year or early next year, when we will have* more flights under our belt.

Mr. FULTON. Well, with the Thor running 50 to 60 percent successful in total flights, and running 16 successful flights in a row, you would say that rocket is at a level where we could call it operational, would you not?

General SCHRIEVER. When I said 50 or 60, that was in February. Since that time that percentage has gone way up. These flights that we have had, these successful flights that we have had have all been with the operational version of the booster. I would say that we probably have at least an 80 percent reliability in the Thor missile today.

Mr. FULTON. And with the Jupiter ranging 70 percent, or above, on successful flights, it is moving along well, too, then; is it not?

General SCHRIEVER. I would say the Jupiter is in about the same category, it has had a very successful flight test program.

Mr. FULTON. Then in carrying out these programs, this is part of the scientific research and development program, is it not, of your particular group?

General SCHRIEVER. Yes, sir.

Mr. FULTON. And the purpose, actually, of the Atlas booster is for both peace as well as for war, so you were doing a dual function; (1) you were possibly making a booster that is operationally capable for missile and armed service use; and (2), you are coming up with a booster that will be operationally successful for NASA and man-in-space "Mercury" use; is that not right?

General SCHRIEVER. That is correct.

Mr. FULTON. So that really you have a dual function in carrying out this particular program, just as various services, military services, carry out broader functions than just for their own particular purposes, many times, do you not?

General SCHRIEVER. Well, this has always been true, particularly in the Air Force, where we have in the development of aircraft taken the lead. You might say the military can and must afford to take bigger steps and move forward, and this has always benefited the civilian aviation.

The CHAIRMAN. Will the gentleman yield? It is not unusual, either, for the military to do that. For instance, the Army Engineers have a peacetime program as well as a wartime program.

General SCHRIEVER. That is correct.

Mr. FULTON. You people have cooperated through the years since 1915 with the civilian research and development of aircraft under NACA, have you not?

General SCHRIEVER. Yes, sir.

Mr. FULTON. So you have worked as well with NASA, the successor to the previous organization, just as you are working with the various elements of the other armed services; is that not right?

General SCHRIEVER. That is correct. We have a few problems to iron out with NASA, because naturally we are in the early phases of space work, and the resources are somewhat limited. It is a matter of allocating the resources that are available, but we have good working relationships with NASA.

As a matter of fact, our former Assistant Secretary for Research and Development, Mr. Horner, has recently moved to NASA. Our relationships with NASA are quite good.

Mr. FULTON. Then we should examine just shortly—and I will be quick—as to the nature of the failures. From what I can see, these are not experimental failures, but rather equipment failures on equipment that has been used for some time. That is, these have not been, in the major part—at least three of the unrelated failures—such failures that have occurred with the use of new equipment, but rather, it has been standard equipment on which something has gone wrong; isn't that right?

General SCHRIEVER. The three unrelated failures were exactly as you described them.

Mr. FULTON. So the question then is, at what point do we in Congress say to the Air Force, along with its contractors, it must make sure that, for example, the electrical equipment functions properly, the valves for the LOX function properly, and the personnel function properly, and that if they do not, they are then guilty of negligence. So my question is: Are we yet at that point that these companies that are contractors should be held responsible under their contract for the failures of just routine mechanical and electrical equipment? For example, in one case it is the electrical signal device that gives a false signal through the failure of just ordinary electrical and electronic circuits.

Second, it is the failure of the ground personnel to shut off the outside liquid oxygen valve which even we amateurs seeing it know that the rocket is ready to go when that valve is shut off. You don't see the trailing white streamer.

Third, it is the hydraulic equipment in ground use that does not function properly. That same thing could occur on a plane or on a locomotive or on most any kind of equipment, even an automobile. Now, when do we say that there is negligence by these companies that causes severe damage to you in your tests?

We in Congress expect failures on new experimental equipment. But here it seems to me, on the three unrelated ones, that there were just plumbing errors, errors that could have been eliminated, because they are just mechanical and electrical. You see, I am distinguishing from your experimental equipment.

General SCHRIEVER. Yes, I know exactly the point you are making. In the first instance I think the only one where you might say that

there is even a question of negligence is the one where the liquid oxygen valve was not closed.

Mr. FULTON. Before you leave that, why didn't someone see there was the white cloud coming out?

General SCHRIEVER. This disconnect occurs at lift-off.

Mr. FULTON. So it wasn't the shut-off, as you usually see it, where the liquid oxygen white cloud stops and then——

General SCHRIEVER. That is right, that is the vent valve that you see closing when the boil-off occurs. This disconnect here occurs when the missile lifts off.

Mr. FULTON. I see.

General SCHRIEVER. There is a pipe coming up to fill this.

Mr. FULTON. So nobody could have seen that?

General SCHRIEVER. Nobody could have seen that, no, sir, until after lift-off. We have gone through many a session with our contractors on personnel discipline. You have been down at Patrick several times. I would like to invite anyone to watch an operation because I think they would find that there is real ironclad discipline involved in these operations. There must be, not only because of the importance of the program, but for safety alone this is necessary. No matter what you do, every now and then somebody goofs. People are people, that is all there is to it. We have been flying airplanes for years and years and years, and yet a very high percentage of all aircraft accidents are personnel errors.

Mr. FULTON. Yes; but isn't it discouraging to you that before you even get to use your experimental equipment, three out of five are plumbing and electrical failures in just ordinary equipment?

General SCHRIEVER. Well, something goes wrong with your car quite often, too, and you have been operating automobiles for years and years. We have had 23 launches where the launcher equipment worked perfectly every time. It happened in this particular case bolts sheared on this [indicating] when the hydraulic equipment actuated the arms. The bolts sheared and the arms stayed in position.

Mr. FULTON. May I say this. I don't want to take too much time, but I want to congratulate you on the work you are doing, and I feel it is being well supervised and you are making real progress.

The question has come up as to how we stand with Russia in this particular field. I believe the Secretary of Defense, Mr. McElroy, has commented that Russia may have eight or nine of this type operational that might have a range as far as continental United States. How do you say we would stand on Russia with that in this particular field? Aren't we pretty much ahead of them on this particular range of the Atlas, on our capabilities and also in demonstrated flight?

General SCHRIEVER. No, sir; I don't believe so. I have stated before, based on the information available to me, that I felt—and I still feel this way—that from a developmental standpoint we are essentially on even terms on the ICBM programs between this country and the U.S.S.R. I feel that they probably will have initially a little more reliability than we will because of the tremendous background of rocket and missile work that dates back to 1945–46 with the Russians. We really didn't get going all-out until 1954, late 1954. You just can't eliminate this as a factor in reliability.

They have got a great deal more background, at least as far as the rocketry is concerned.

Now, guidancewise, nose-cone-wise, nuclear-warhead-wise, I certainly don't think that they are ahead of us in these fields, but probably in the overall reliability they will have a little higher reliability initially than we will.

The CHAIRMAN. Mr. Anfuso.

Mr. ANFUSO. General, you said that we didn't get started until late 1954. Now, isn't it a fact that we actually started prior to 1953, that the Air Force was conducting missile tests in Cape Canaveral in 1953 and before?

General SCHRIEVER. Yes; we were conducting missile tests. I am talking about ballistic rocket missiles. We started—of course, on a very low level of effort—work on long-range ballistic missiles as early as 1946, but it wasn't until after the Von Neumann Committee made its report to the Air Force in early 1954 that these programs or this particular program was put on a high priority. The first 6 or 8 months of time after this report was made were spent on more detailed engineering studies and analysis to reorient the program that was then in being.

So I say late 1954 was the time that we really started all out with respect to the hardware development in the ballistic missile field, not in other missiles. I am talking now about the ballistic missiles.

Mr. ANFUSO. Well, when was the Atlas program started?

General SCHRIEVER. I have forgotten when it first got the name "Atlas," but the Atlas program, as you see it here now, really started in November—I mean the present version—started in November of 1954.

Mr. ANFUSO. When was the prior version started?

General SCHRIEVER. I think it was 1951, but I can check this and make sure.

Mr. ANFUSO. The latter part of 1951; isn't that correct?

General SCHRIEVER. I believe so; yes.

Mr. ANFUSO. Didn't the Secretary of Defense recently make a statement that the Atlas would be operational in 60 days?

General SCHRIEVER. He said it would slip about 60 days.

Mr. ANFUSO. When do you think the Atlas program will be in operation?

General SCHRIEVER. I feel that we should have the beginning of an operational capability—and that is not a squadron's worth, this is just the first complex of missiles—around the first of September. In other words, about 60 days after our July 1, 1959, target date which we have had for the last 3 or 4 years.

Mr. ANFUSO. Of this year?

General SCHRIEVER. Yes, sir; this year.

Mr. ANFUSO. Now, General, who is in charge of operations at Cape Canaveral? Is the Air Force?

General SCHRIEVER. Yes, sir; the Air Force is.

Mr. ANFUSO. Well, isn't it a fact that the Air Force made a contract with Pan American in 1953 and released control of Cape Canaveral to Pan American?

General SCHRIEVER. No; Pan American has a contract with the Air Force to operate the down-range stations and operate the cape.

In other words, Pan American is a contractor of the Air Force and works directly under Air Force supervision at Patrick.

Mr. ANFUSO. Pan American personnel work on these missiles, don't they?

General SCHRIEVER. They don't work on the missiles. The missiles themselves are all directly under Air Force supervision, but the industrial contractors form the team that does the launching at Cape Canaveral. In other words, Pan American doesn't operate any of the launches, for example.

Mr. ANFUSO. Well, General, wasn't it a Pan American technician who lost a $2 million Thor missile by carelessly crossing wires in the DOVAP system?

General SCHRIEVER. You are talking about the second Thor, where we had a range safety problem and the missile appeared to be going inland instead of out to sea. This was not because of a crossed wire; it was because of an ambiguity in actually checking out the radar. It had to do with the DOVAP, all right. I would have to check back into the details of this, myself, and I would rather give you the details in executive session.

Mr. ANFUSO. I wish you would because the statement was made to me that a Thor missile was lost because a Pan American technician carelessly crossed the wrong wires. I would like to get the facts on that.

General SCHRIEVER. We made a full investigation on that. It happened over 2 years ago, and I am just a little bit hazy on the exact details, but I would be glad to make them available to the committee.

(The information is as follows:)

SUMMARY OF THOR MISSILE NO. 102 LAUNCH

Thor missile No. 102 (test No. 527) was launched from AFMTC, Patrick Air Force Base, Fla., at 2331 eastern standard time, April 19, 1957. This was the second Thor launch attempt, with limited previous experience from which to benefit, since the first Thor was hardly off the launch pad before losing thrust and settling back to explode on the pad. The missile was successfully launched and flew in a stable manner until 34.75 seconds after lift-off when the flight was terminated by Range Safety Destruct Command. The decision to destruct was based upon a position plot from the DOVAP ELSSE tracking radar which showed the missile to be programing up range instead of down range. The requirement for immediate decision and reaction under such circumstances is obvious. Later data evaluation proved conclusively that the missile was programing properly down range and in a very stable condition, and thereby had satisfied certain major test objectives; e.g., missile performance was extremely satisfactory, and the control system was stable. It was subsequently determined that the erroneous position plot was due to a polarity reversal in the presentation portion of the DOVAP ELSSE system, which in turn was the result of improper wiring.

Corrective action was taken which required a revised checkout procedure by RCA of this radar system prior to launch. This consisted of installing a transponder in a jeep and/or aircraft, have either of these vehicles move in a predetermined direction with the DOVAP system tracking and then check the presentation of this movement to insure that it actually indicated the proper direction. This was accomplished approximately 2 hours prior to each launch. Since Thor missile No. 107 this system has not been used and the primary range safety equipment is now Azusa, correlated with Mod II radar and optical sky screen (visual reference of missile trajectory on a grid). Azusa provides more advanced capabilities than did DOVAP ELSSE.

DOVAP ELSSE is essentially a range safety system which tracks the missile and provides a visual plotting board presentation of both the actual missile

trajectory, and of superimposed safe operation limits of trajectory. Azusa is a radar electronic computation system, and is used in conjunction with a transponder in the missile. By tuning to this transponder frequency and tracking, it provides information on the missile trajectory in relation to two planes of reference. This information is processed by digital computers which are integrated into the system and which provide both missile position and instantaneous predictions of impact point data.

Mr. ANFUSO. What, exactly, are Pan American's functions at Cape Canaveral?

General SCHRIEVER. Well, they provide, first of all, all of the support at Cape Canaveral in the way of providing guards. They provide support in the way of logistics; that is, they furnish the liquid oxygen. They don't make it, they transport it to the launch stands. RCA is a subcontractor of Pan American, and they operate all of the electronics—the instrumentation facilities located on the cape, as well as the instrumentation facilities located on the down-range stations. The down-range stations are manned by Pan American-RCA personnel. There is one officer who actually is in command of the station, but all of the work at these stations is performed by the contractor personnel.

Mr. ANFUSO. General, can you supply for the record the contract that was actually made between Pan American and the Air Force in 1953?

General SCHRIEVER. Yes, sir, I can.

(The information requested is as follows:)

SUPPLEMENTAL AGREEMENT NO. 10
to Contract No. AF 18(600)-881
Classification Unclassified
PR MTM-56-2
Initiator B.A. SUSTARE
Buyer B.A. SUSTARE

SUPPLEMENTAL AGREEMENT
TO
COST-PLUS-A-FIXED-FEE CONTRACT
for
SERVICES

DEPARTMENT OF THE AIR FORCE
(UNITED STATES AIR FORCE)

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC

SUPPLEMENTAL AGREEMENT FOR: INCREASE IN FUNDS

CHANGE IN ESTIMATED COST: $30,000 (INCREASE)

CHANGE IN FIXED FEE: NONE

Payments to be made by the FINANCE OFFICER, HEADQUARTERS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, FLORIDA

The supplies and services, if any, to be obtained by this instrument are authorized by, are for the purpose set forth in, and are chargeable to the allotments below enumerated under the heading "DEBIT", the available balances of which are sufficient to cover the cost thereof. The reduction, if any, in estimated cost and fixed fee under this instrument will result in credits to the allotments below enumerated under the heading "CREDIT".

DEBIT: Paragraph 2 (b) of Section IV of Revised Technical Exhibit "I"
(For period 1 January 1956 through 30 June 1956)
chargeable to: 5763500 047-6008 P551-08 S08-606
PR No. MTM-56-2 $ 55,000.00

CREDIT: 57X3600 647-6008 647-6008 P690-07 S08-606 $ 25,000.00

ADMINISTRATIVE OFFICE: Headquarters Air Force Missile Test Center
Patrick Air Force Base, Florida

This negotiated Supplemental Agreement is entered into pursuant to the provisions of the Armed Services Procurement Act of 1947 (Public Law 413, 80th Congress), and the basic contract.

TO: PAN AMERICAN WORLD AIRWAYS, INC
135 East 42nd Street
Chrysler Building
New York 17, New York

21 May 1956

SUBJECT: INCREASE IN FUNDS

CHANGE IN ESTIMATED COST: $ 30,000.00 (Increase)

CHANGE IN FIXED FEE: NONE

WHEREAS, the Government and Pan American World Airways are parties of a contract entered into as of the 31st day of December 1953, as amended by Supplemental Agreements 1 through 9; and

WHEREAS, the parties desire to amend said contract to increase the funds allotted to cover messing of Enlisted Personnel of the U.S. Armed Forces and to permit removal of funds incident to rental of an Electronic Data Processing Machine since slippage of the Impact Predictor Program removes the need for rental of such machines at this time;

NOW, THEREFORE, the subject contract, as amended, is hereby further amended and supplemented as follows:

FIRST: Part III - CONSIDERATION AND PAYMENT of the SCHEDULE is amended as follows:

a. By increasing the estimated costs set forth in sub-paragraph A (1) by the sum of THIRTY THOUSAND DOLLARS AND NO CENTS ($30,000.00), thereby making the total estimated costs for the contract THIRTY FOUR MILLION SIX HUNDRED NINETY TWO THOUSAND NINE HUNDRED EIGHTY DOLLARS AND FIFTY CENTS ($34,692,980.50).

b. By increasing the amount allotted for the contract set forth in sub-paragraph A (3) by the sum of THIRTY THOUSAND DOLLARS AND NO CENTS ($30,000.00), thereby making the total amount allotted for the contract THIRTY FIVE MILLION EIGHT HUNDRED FORTY SEVEN THOUSAND NINE HUNDRED EIGHTY DOLLARS AND FIFTY CENTS ($35,847,980.50).

c. By adding the following sub-paragraph (3) under Paragraph B:

"(3) Cost of rental of administrative or warehouse space to the extent that such rentals are expressly approved by the Contracting Officer."

. Nothing herein contained shall be deemed to require the Contractor to manufacture, furnish or deliver any articles or supplies or to perform any work as to which a Notice of Termination is in effect at the effective date of this Supplemental Agreement not to require the Government to accept any such articles, supplies or work and any such Notice of Termination shall be applicable to the extent stated therein to any articles, supplies or work called for by this Supplemental Agreement or otherwise referred to in this Supplemental Agreement.

. Except as hereby modified, either expressly or by necessary implication, all the terms, covenants and conditions of the contract affected shall continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

WITNESSES

By_____

D. N. YATES, Maj Gen, USAF
(Contracting Officer)

PAN AMERICAN WORLD AIRWAYS, INC
(Contractor)

NOTE: In case of corporation, witnesses not required but certificate below must be completed. Type or print names under all signatures.

By_____

_____
(Title)

_____
(Address)

NOTE: Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

CERTIFICATE

I, _____ certify that I am the _____ of the corporation named as Contractor herein; that _____, who signed this Supplemental Agreement on behalf of the Contractor, was then _____ of said corporation; that said Supplemental Agreement was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

_____ (CORPORATE SEAL)
(SIGNATURE)

Letter Contract Designated
Supplemental Agreement No.9 to
Contract No. AF 18(600)-881

LETTER CONTRACT
between
DEPARTMENT OF THE AIR FORCE
and

PAN AMERICAN WORLD AIRWAYS, INC.
(Contractor)

Contract For: Amendment of subject contract to provide for Contractor furnishing certain commercial vehicles

Place: Air Force Missile Test Center, Patrick Air Force Base, Florida

Administrative Information: Finance Officer, Hq Air Force Missile Test Center, Patrick Air Force Base, Florida

is designated as the officer to make payments, if any, in accordance with this contract.

The sums to be expended by the Government hereunder are chargeable to the following allotments, the available balances of which are sufficient to cover the same:

DEBIT: 57X3600 647-6008 P690-07 S 08-606 $350,000.00
PR No. MTGR-56-1

The office having overall administrative responsibility for this contract is: Administrative Contracting Officer, Hq Air Force Missile Test Center, Patrick Air Force Base, Florida

Contractor's invoices or vendor's shipping documents used as invoices shall be made out to the Finance Officer designated to make payment hereunder, if any, and shall be sent by the Contractor to the Administrative Office for recording and forwarding to the Finance Officer for payment.

Point of Inspection and Acceptance and F.O.B. Point: _____

Type Contract Contemplated: Supplemental Agreement No. 9 to CPFF Contract AF 18(600)-881

Purchase Request No.: MTGR 56-1

Buyer: Beverly A. Sustare

Equipment Class: None

Program: None

This instrument has been negotiated pursuant to Section 2(c)(1) of Public Law 413, 80th Congress.

DEPARTMENT OF THE AIR FORCE
AIR FORCE MISSILE TEST CENTER
Patrick Air Force Base (ARDC)
Florida

Letter Contract

Letter Contract Designated
Supplemental Agreement No.9 to
Contract No. AF 18(600)-881

NAME: PAN AMERICAN WORLD AIRWAYS, INC
GUIDED MISSILES RANGE DIVISION

16 November 1955

ADDRESS: CMU Box 308, Patrick Air Force Base
Florida

Dear Sirs:

1. Introductory Paragraph.—An order is hereby placed with the Contractor for the furnishing to the Government of the supplies or services set forth in Exhibit "A" attached hereto and hereby made a part hereof.

2. Direction to Proceed.—Except as otherwise expressly provided to the contrary herein, the Contractor is directed, upon its acceptance of this order, to proceed immediately to procure the necessary materials, and to commence the manufacture of the supplies or performance of the services called for herein, and to pursue such work with all diligence to the end that the supplies may be delivered or services performed at the earliest practicable date.

3. Contract Clauses Incorporated by Reference.-- The applicable provisions of the clauses set forth in the General Provisions of the Basic Contract No. AF 18(600)-881 are hereby incorporated into this Letter Contract by reference.

4. Provision for Definitising Contract.—By the Contractor's acceptance hereof, it undertakes, without delay, to enter into negotiations with the Department of the Air Force looking to the execution of a definitive contract which will include the clauses enumerated above and all other applicable clauses then required by Federal law, Executive Order, and applicable Procurement Regulations to be included in contracts for supplies or services of the kind herein described. The definitive contract will also contain a detailed delivery schedule, estimated cost, fixed fee, if any, terms and conditions as agreed to by the parties which may or may not be at variance with the provisions of this order. It is expected that such definitive contract will be executed prior to 28 February 1956, and will be a cost-reimbursement-type contract.

5. Authority to Obligate Funds.—The Contractor is not authorized to expend or obligate, in furtherance of its performance hereunder, more than $ 350,000 in the aggregate.

Letter Contract (CPFF)

MCP 71-6A, 1 Nov 54

6. Termination.—(a) In case a definitive contract is not executed by the date specified in the clause hereof entitled "Provision for Definitising Contract" because of the inability of the parties to agree upon a definitive contract, this order may be terminated in its entirety by either party by delivering to the other party a notice in writing specifying the effective date of termination, which date shall not be earlier than thirty (30) days after receipt of such notice.

(b) The performance of work under this order may be terminated by the Government in accordance with this clause in whole, or from time to time in part, whenever the Contracting Officer shall determine that such termination is in the best interests of the Government. Any such termination shall be effected by delivery to the Contractor of a Notice of Termination specifying the extent to which performance of work under this order is terminated, and the date upon which such termination becomes effective.

(c) After receipt of a Notice of Termination, and except as otherwise directed by the Contracting Officer, Contractor shall (1) stop work under this order on the date and to the extent specified in the Notice of Termination; (2) place no further orders or subcontracts for materials, services or facilities except as may be necessary for completion of such portion of the work under this order as is not terminated; (3) terminate all orders and subcontracts to the extent that they relate to the performance of work terminated by the Notice of Termination; (4) assign to the Government, in the manner, at the times, and to the extent directed by the Contracting Officer, all of the right, title and interest of the Contractor under the orders or subcontracts so terminated; (5) settle all outstanding liabilities and all claims arising out of such termination of orders and subcontracts with the approval or ratification of the Contracting Officer to the extent he may require which approval or ratification shall be final for all purposes of this clause; (6) transfer title to and deliver to the Government, in the manner, at the times and to the extent, if any, directed by the Contracting Officer, (i) the fabricated or unfabricated parts, work in process, completed work, supplies, and other material produced as a part of, or acquired in respect of the performance of, the work terminated by the Notice of Termination, (ii) the completed or partially completed plans, drawings, information and other property which, if this order had been completed, would be required to be furnished to the Government; (7) use its best efforts to sell in the manner, at the times, to the extent, and at the price or prices directed or authorized by the Contracting Officer, any property of the types referred to in provision (6) of this paragraph, provided, however, that the Contractor (i) shall not be required to extend credit to any purchaser, and (ii) may require any such property under the conditions prescribed by and at a price or prices approved by the Contracting Officer; and provided further, that the proceeds of any such transfer or disposition shall be applied in reduction of any payments to be made by the Government to the Contractor under this order or shall otherwise be credited to the price or cost of work covered by this order or paid in such other manner as the Contracting Officer may direct; (8) complete performance of such part of the work as shall not have been terminated by the Notice of Termination; and (9) take such action as may be necessary or as the Contracting Officer may direct, for the protection and preservation of the property related to this order which is in the possession of the Contractor and in which the Government has or may acquire an interest. At any time after expiration of the plant clearance period, as defined in Section VIII, Armed Services Procurement Regulation, or as it may be amended from time to time, the Contractor may submit to the Contracting Officer a list, certified as to quantity and quality, of any or all items of termination inventory not previously disposed of, exclusive of items the disposition of which has been directed or authorized by the Contracting Officer, and may request the Government to remove such items or enter into a storage agreement covering them. Not later than fifteen (15) days thereafter, the Government will accept title to such items and remove them or enter into a storage agreement covering the same; provided that the list submitted shall be subject to verification by the Contracting Officer upon removal of the items, or if the items are stored, within forty-five (45) days from the date of submission of the list, and any necessary adjustments to correct the list as submitted shall be made prior to final settlement.

(d) After receipt of a Notice of Termination, the Contractor shall submit to the Contracting Officer its termination claim in the form and with the certification prescribed by the Contracting Officer. Such claim shall be submitted promptly but in no event later than two years from the effective date of termination, unless one or more extensions in writing are granted by the Contracting Officer upon request of the Contractor made in writing within such two-year period or authorized extension thereof. However, if the Contracting Officer determines that the facts justify such action, he may receive and act upon any such termination claim at any time after such two-year period or any extension thereof. Upon failure of the Contractor to submit a termination claim within the time allowed, the Contracting Officer may determine, on the basis of information available to him, the amount, if any, due the Contractor by reason of the termination, and shall thereupon pay to the Contractor the amount so determined.

(e) Subject to the provision of paragraph (d) hereof, the Contractor and the Contracting Officer may agree upon the whole or any part of the amount or amounts to be paid to the Contractor by reason of the total or partial termination of work pursuant to this clause. In the event of any termination pursuant to paragraph (a) hereof, such amount or amounts shall not include any allowance for profit or fee. In the event of any termination pursuant to paragraph (b) hereof, such amount or amounts may include a reasonable allowance for profit or fee, but only on work actually done in connection with the terminated portion of this order. Any such amount shall not exceed the amount set forth in the clause hereof entitled "Authority to Obligate Funds . . ." Any such agreement shall be embodied in an amendment to this order and the Contractor shall be paid the agreed amount.

(f) If the Contractor and the Contracting Officer are not able to agree in whole or in part, as provided in paragraph (e) hereof, as to the amount or amounts to be paid to the Contractor in connection with the termination of work pursuant to this clause, the Government, without duplication of any amounts agreed upon in accordance with the above-cited paragraph (e), shall pay to the Contractor an amount determined in accordance with the applicable cost principles of the Armed Services Procurement Regulation. In the event of the termination of this order pursuant to paragraph (a) hereof, no allowance for fee or profit shall be included in the amount to be paid the Contractor.

(g) The Contractor shall have the right of appeal, under the clause entitled "Disputes" incorporated in this order by reference, from any determination made by the Contracting Officer under paragraph (d) or (f) above (including any dispute as to whether termination has in fact taken place pursuant to paragraph (a) hereof), except that if the Contractor has failed to submit a claim within the time provided in paragraph (d) hereof and has failed

Letter Contract Designated
Supplemental Agreement No. 9
to Contract AF 18(600)-881

MCP 71-4C, 1 Nov 54

44988 O—59——3

to request extension of such time, the Contractor shall have no such right of appeal. In any case where the Contracting Officer has made a determination of the amount due under paragraph (d) or (f) above, the Government shall pay to the Contractor the following: (i) if there is no right of appeal hereunder or if no timely appeal has been taken, the amount so determined by the Contracting Officer, or (ii) if an appeal has been taken, the amount finally determined on such appeal.

(h) In arriving at the amount due to the Contractor under this clause there shall be deducted (1) all unliquidated advance or other unliquidated payments theretofore made to the Contractor, (2) any claim which the Government may have against the Contractor in connection with this contract, and (3) the agreed price for, or the proceeds of sale of, any materials, supplies or other things acquired by the Contractor or sold pursuant to the provisions of this clause and not otherwise recovered by or credited to the Government.

(i) The Government may from time to time, under such terms and conditions as it may prescribe, make partial payments and payments on account against costs incurred by the Contractor in connection with the terminated portion of the contract whenever in the opinion of the Contracting Officer the aggregate of such payments shall be within the amount to which the Contractor will be entitled hereunder. If the total of such payments is in excess of the amount finally agreed or determined to be under this clause, such excess shall be payable by the Contractor to the Government upon demand together with interest computed at the rate of 6% per annum, for the period from the date such excess payment is received by the Contractor to the date on which such excess is repaid to the Government; provided, however, that no interest shall be charged with respect to any such excess payment attributed to a reduction in the Contractor's claim by reason of retention or other disposition of termination inventory until ten days after the date of such retention or disposition.

(j) Unless otherwise provided in this contract or by applicable statute, the Contractor, from the effective date of termination and for a period of six years after final settlement under this order, shall preserve and make available to the Government, at all reasonable times at the office of the Contractor without direct charge to the Government, all books, records, documents, and other evidence bearing on the cost and expenses under this order and relating to the work terminated, or, to the extent approved by the Contracting Officer, photographs, microphotographs, or other authentic reproductions thereof.

7. Quality Control Specification.—Except as otherwise provided in this contract, the Contractor's system of quality control during the performance of this contract shall be in accordance with the provisions of Military Specification MIL-Q-5923, as in effect on the date of this contract, incorporated herein by reference, unless this contract is one of the types specified in paragraph 1.2 of said specification.

8. Renegotiation.—(a) This contract shall be subject to any Act of the Congress, whether heretofore or hereafter enacted and to the extent indicated therein, providing for the renegotiation of said contract and shall be deemed to contain all the provisions required by any such Act without subsequent amendment of this contract specifically incorporating such provisions.

(b) The Contractor (which term, as used in this clause, means the party contracting to furnish the materials or perform the work required by this contract) agrees to insert the provisions of this clause, including this paragraph (b) in subcontracts as defined in Section 103(g) of the Renegotiation Act of 1951 (P.L. 9, 82nd Congress), except any subcontracts of a class or type described in Section 106(a) of the Renegotiation Act of 1951.

(c) Nothing contained in this clause shall impose any renegotiation obligation with respect to this contract or any subcontract hereunder which is not imposed by an Act of Congress, heretofore or hereafter enacted.

9. Provision for Execution.—The Contractor's acceptance of this order will be indicated by affixing its signature to three copies thereof and returning the executed copies to the Contracting Officer not later than 28 November 1955. Such acceptance will constitute this order a contract on the terms set forth herein.

THE UNITED STATES OF AMERICA

By WILLIAM E. ELDER

WILLIAM E. ELDER, Col., USAF
(Contracting Officer)
Commander

Accepted November 25, 1955, 19

Pan American World Airways, Inc
(Contractor) Affix Corporate Seal

By FRANKLIN GLEDHILL
(Signature of Official)
Franklin Gledhill, Vice President

Letter Contract Designated
Supplemental Agreement No.
to Contract AF 18(600)-82

NOTE: Type or print names under all signatures

—3—

DCP 71-62D, 1 Nov 54

EXHIBIT A

To Letter Contract Designated Supplemental
Agreement No. 9 to Contract AF 18(600)-881

To amend subject contract to provide that the Contractor shall furnish commercial vehicles required for the performance of Contract AF 18(600)-881 at Cape Canaveral Auxiliary Air Force Base in accordance with "ARDC Policy on Vehicles for Contractors" dated 18 August 1955, by deleting paragraph 3, Section VI - "Government Furnished Equipment and Services", Revised Technical Exhibit "I" dated 31 July 1954 and substituting the following paragraph 3 in lieu thereof:

"3. The Air Force will transfer to the Contractor the necessary General Purpose and Special Purpose Vehicles approved by the Contracting Officer for use at Down Range Sites of the Missile Test Range. Vehicular requirements of the Contractor other than for Down Range Sites, shall be in accordance with 'ARDC Policy on Vehicles for Contractors' dated 18 August 1955, attached hereto as Annex I. The maintenance of Government furnished vehicles will be accomplished according to AFM 77-1."

18 Aug 55

ARDC Policy on Vehicles for Contractors

1. The following policies are established for the providing of vehicles for those contractors funded from the P-600 Appropriations.

a. This Command will not furnish such contractors with government owned vehicles except:

(1) Vehicles required for use on down range stations under the command of AFMTC.

(2) USAF noncommercial special purpose vehicles, noncommercial construction equipment and noncommercial materials handling equipment will be supplied only when commercial counterparts are not useable or procurable.

(3) Any other exceptions will be brought to the attention of this headquarters for a determination as to the method of supply that is in the best interests of the government. Title to AF vehicles supplied to contractors will remain with the USAF.

b. Request for initial assignment of vehicles from Air Force assets will be forwarded to Headquarters AMC through this headquarters for approval.

c. Instructions for programming of vehicles required from Air Force assets as listed in the exceptions above will be furnished by this headquarters. Future contracts will be so written to include authorization for this type programming.

2. Where the above restrictions apply and vehicles other than GFE are required by contractors in performance of cost type contracts, such vehicles may be provided through the following actions:

a. Contractor may obtain vehicles on a lease or rental basis.

b. Contractor may utilize vehicles which are the property of and where title remains with the contractor.

Annex I to Exhibit A to Letter Contract Designated Supplemental Agreement No. 9 to Contract AF 18(600)-581

c. In the case cited in 2a above, the contractor's request for reimbursement will be accepted as a reimbursable cost when the rental or lease rates are determined to be reasonable.

d. In the case of 2b above, the contractor will be reimbursed on the basis of reasonable depreciation.

e. The Contracting Officer will be the approval authority as to whether or not the requirement and the cost is authorized.

3. Gasoline, oil and grease will be furnished by the Air Force for vehicles leased or purchased as required in the performance of the contract when contractor is located on or adjacent to an Air Force Base.

4. The leased or purchased vehicles will each bear a small, inexpensive, removable identification so that they may be readily recognized. No other markings will be prescribed for these vehicles.

5. Funds required in support of this policy will be those quoted on existing basic contracts.

6. Center commanders may, at their option, dispatch vehicles from the Motor Pool to contractors for short periods of time in performance of their stated contracts.

7. Air Force vehicles presently in the hands of contractors will be recaptured and reported to AMC through this headquarters (ATTN: RDSM) for redistribution. Recapture will proceed at a uniform rate starting not later than 1 November 1955. Target date for complete recapture of Air Force vehicles is 30 June 1956.

8. The foregoing does not preculde the release of vehicles as GFE for USAF contractor support when they can be furnished from assets excess to programmed Air Force requirements; however, AF vehicles will not be authorized any contractor before formal determination of availability is made.

SUPPLEMENTAL AGREEMENT NO. 8
to Contract No. AF 18 (600)-881

CLASSIFICATION None

PR None

INITIATOR BEVERLY A. SUSTARE, MTGA

BUYER - BEVERLY A. SUSTARE, MTGA

SUPPLEMENTAL AGREEMENT
TO
COST-PLUS-A-FIXED-FEE CONTRACT
for
SERVICES

DEPARTMENT OF THE AIR FORCE

(UNITED STATES AIR FORCE)

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.

SUPPLEMENTAL AGREEMENT FOR: DECREASE IN FUNDS

CHANGE IN ESTIMATED COST: $22,903.50 (DECREASE)

CHANGE IN FIXED FEE: NONE

Payments to be made by the FINANCE OFFICER, HEADQUARTERS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, FLORIDA

The supplies and services, if any, to be obtained by this instrument are authorized by, are for the purpose set forth in, and are chargeable to the allotments below enumerated under the heading "Debit", the available balances of which are sufficient to cover the cost thereof. The reduction, if any, in estimated cost and fixed fee under this instrument will result in credits to the allotments below enumerated under the heading "Credit."

CREDIT: 5753500 047-5008 551-08 808-606

DEBIT : NONE

ADMINISTRATIVE OFFICE: HEADQUARTERS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, FLORIDA

This negotiated Supplemental Agreement is entered into pursuant to the provisions of Section 2(c)(1) of the Armed Services Procurement Act of 1947 (Public Law 413, 80th Congress), and any required determination and findings have been made.

1 September 1955

TO: PAN AMERICAN WORLD AIRWAYS, INC.
135 East 42nd Street
Chrysler Building
New York 17, New York

SUBJECT: DECREASE IN FUNDS

CHANGE IN ESTIMATED COST: $22,903.50 (DECREASE)

CHANGE IN FIXED FEE: NONE

1. The subject Contract, as amended, is hereby further amended and supplemented in the following particulars:

FIRST: By amending Part III - CONSIDERATION AND PAYMENT of the Schedule as follows:

a) By decreasing the estimated cost set forth in sub-paragraph A. (1) by the sum of TWENTY TWO THOUSAND NINE HUNDRED THREE DOLLARS AND FIFTY CENTS ($22,903.50) thereby making the total estimated cost for the contract THIRTY THREE MILLION TWO HUNDRED EIGHTY FIVE THOUSAND SEVEN HUNDRED SIXTY FIVE DOLLARS AND FIFTY CENTS ($33,285,765.50)

b) By decreasing the amount allotted for the contract as set forth in sub-paragraph A. (3) by the sum of TWENTY TWO THOUSAND NINE HUNDRED THREE DOLLARS AND FIFTY CENTS ($22,903.50) thereby making the total amount allotted for the contract THIRTY FOUR MILLION FOUR HUNDRED TWENTY THOUSAND SEVEN HUNDRED SIXTY FIVE DOLLARS AND FIFTY CENTS ($34,420,765.50)

2. Nothing herein contained shall be deemed to require the Contractor to manufacture, furnish or deliver any articles or supplies or to perform any work as to which a Notice of Termination is in effect at the effective date of this Supplemental Agreement not to require the Government to accept any such articles, supplies or work and any such Notice of Termination shall be applicable to the extent stated therein to any articles, supplies or work called for by this Supplemental Agreement or otherwise referred to in this Supplemental Agreement.

3. Except as hereby modified, either expressly or by necessary implication, all the terms, covenants and conditions of the contract affected shall continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

WITNESSES

By /S/ D. N. YATES

D. N. YATES, Maj Gen, USAF
(Contracting Officer)

PAN AMERICAN WORLD AIRWAYS, INC
(Contractor)

NOTE: In case of corporation, witnesses not required but certificate below must be completed. Type or print names under all signatures.

By /S/ J. C. Leslie
J. C. Leslie
Vice President
(Title)

135 East 42nd Street
New York 17, N. Y.
(Address)

NOTE: Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

C E R T I F I C A T E

I, H. Preston Morris certify that I am the Secretary of the corporation named as Contractor herein; that J. C. Leslie, who signed this Supplemental Agreement on behalf of the Contractor, was then a Vice President of said corporation; that said Supplemental Agreement was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

H. Preston Morris (CORPORATE SEAL)
(SIGNATURE)

SUPPLEMENTAL AGREEMENT NO. 7 TO
CONTRACT AF 18(600)-881

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.
Chrysler Building
New York 17, New York

SUBJECT SUPPLEMENTAL AGREEMENT IS APPROVED.

X

X

X

X

X

X

X

X

X

X

X

X

X

X

X

X

X

X APPROVED 15 August 1955

/S/ Lee W. Fulton
LEE W. FULTON
Colonel, USAF
Director of Procurement

RDP 71-22B
1 AUG 51

SUPPLEMENTAL AGREEMENT NO. 7
to Contract No. AF 18(600)-881

CLASSIFICATION Unclassified

PR MTR-56-1

INITIATOR BEVERLY A. SUSTARE, MTGA

BUYER BEVERLY A. SUSTARE, MTGA

SUPPLEMENTAL AGREEMENT
TO
COST-PLUS-A-FIXED-FEE CONTRACT
for
SERVICES

DEPARTMENT OF THE AIR FORCE

(UNITED STATES AIR FORCE)

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.

SUPPLEMENTAL AGREEMENT FOR: ADDITIONAL WORK AND EXTENSION OF TIME

CHANGE IN ESTIMATED COST: $16,741,209.00 (INCREASE)

CHANGE IN FIXED FEE: $ 480,000.00 (INCREASE)

Payments to be made by the FINANCE OFFICER, HEADQUARTERS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, FLORIDA

The supplies and services, if any, to be obtained by this instrument are authorized by, are for the purpose set forth in, and are chargeable to the allotments below enumerated under the heading "Debit", the available balances of which are sufficient to cover the cost thereof. The reduction, if any, in estimated cost and fixed fee under this instrument will result in credits to the allotments below enumerated under the heading "Credit".

DEBIT: 57X3600 647-6008 P690-07 S 08-606 $17,221,209.00
PR No. MTR-56-1

ADMINISTRATIVE OFFICE: HEADQUARTERS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, FLORIDA

This negotiated Supplemental Agreement is entered into pursuant to the provisions of Section 2(c)(1) of the Armed Services Procurement Act of 1947 (Public Law 413, 80th Congress), and any required determination and findings have been made.

11 July 1955

TO: PAN AMERICAN WORLD AIRWAYS, INC.
135 East 42nd Street
Chrysler Building
New York 17, New York

SUBJECT: ADDITIONAL WORK AND EXTENSION OF TIME

CHANGE IN ESTIMATED COST: $16,741,209.00 - (INCREASE)

CHANGE IN FIXED FEE: $ 480,000.00 - (INCREASE)

1. The subject contract, as amended, is hereby further amended and supplemented in the following particulars:

FIRST: PART I - STATEMENT OF WORK of the SCHEDULE is amended as follows:

a. By deleting subparagraph (1) of paragraph A. in its entirety and substituting the following therefor:

"(1) Administration, management and planning for (2), (3), (4), and (5) below, with Headquarters at Patrick Air Force Base as set forth in Section I of Technical Exhibit "I" attached hereto;"

b. By adding the following subparagraphs (5) and (6):

"(5) Construction work incidental and necessary to the management, operation and maintenance of the Missile Test Range subject to the provisions of Part VI of this SCHEDULE."

"(6) All references in this contract to Technical Exhibit I shall be deemed to refer to such Technical Exhibit as revised from time to time by supplemental agreement to this contract.

c. By deleting paragraph D. in its entirety and substituting the following therefor, effective 1 August 1955.

"D. Performance of this contract during the period set forth in Part II of the SCHEDULE does not contemplate the staffing or

assumption of operational status of Auxiliary Air Force Base No. 12 (classified) or additional satellite stations referred to in the last sentence of paragraph B. above. If staffing or assumption of operational status of such be required, this contract shall be amended accordingly."

SECOND: PART II - TIME OF PERFORMANCE AND DELIVERY INSTRUCTIONS of the SCHEDULE is amended as follows:

a. By deleting paragraph A., as amended, in its entirety and substituting the following therefor:

"A. The Contractor shall perform the services called for herein during the period 30 June 1953 through 30 June 1956, except that the work to be performed under paragraph 10, SECTION V, of Revised Technical Exhibit "I" shall have commenced on 1 May 1954 and shall be completed by 31 December 1955, and the work to be performed under SECTION VII of Revised Technical Exhibit "I" shall have commenced on 15 July 1954."

THIRD: PART III - CONSIDERATION AND PAYMENT of the SCHEDULE is amended as follows:

a. By increasing the estimated cost set forth in sub-paragraph A(1) by the sum of SIXTEEN MILLION SEVEN HUNDRED FORTY-ONE THOUSAND TWO HUNDRED NINE DOLLARS AND NO CENTS ($16,741,209.00), thereby making the total estimated cost for the contract THIRTY-THREE MILLION THREE HUNDRED EIGHT THOUSAND SIX HUNDRED SIXTY-NINE DOLLARS AND NO CENTS ($33,308,669.00).

b. By increasing the fixed fee set forth in sub-paragraph A(2) by the sum of FOUR HUNDRED EIGHTY THOUSAND DOLLARS AND NO CENTS ($480,000.00), thereby making the total fixed fee for the contract ONE MILLION ONE HUNDRED THIRTY-FIVE THOUSAND DOLLARS AND NO CENTS ($1,135,000.00).

c. By increasing the amount allotted for the contract as set forth in subparagraph A(3) by the sum of SEVENTEEN MILLION TWO HUNDRED TWENTY-ONE THOUSAND TWO HUNDRED NINE DOLLARS AND NO CENTS ($17,221,209.00), thereby making the total amount allotted for the contract THIRTY-FOUR MILLION FOUR HUNDRED FORTY-THREE THOUSAND SIX HUNDRED SIXTY-NINE DOLLARS AND NO CENTS ($34,443,669.00).

d. By deleting sub-paragraph D., as amended, in its entirety and substituting the following paragraph therefor:

"D. The fixed overhead amounts covering all overhead indirect costs contemplated by Clause 4(i) of the General Provisions shall be the amount or amounts for the period or periods set forth below:

AMOUNT	APPLICABLE PERIOD	
	FROM	TO
$135,596.00	30 June 1953	31 July 1954
$395,000.00	1 Aug 1954	31 July 1955
$430,000.00	1 Aug 1955	30 June 1956

Revisions of the overhead amount contemplated by Clause 4(j) of the General Provisions shall be for a period or periods

coinciding with subsequent extensions of the period of performance of this contract as set forth in PART II of this SCHEDULE. The Contractor shall be paid the fixed overhead amounts set forth above in equal monthly installments during the respective periods of application.

e. By deleting paragraph E. in its entirety, effective 1 August 1955.

f. By redesignating the present sub-paragraph F. as Paragraph E.

FOURTH: PART VI - CONSTRUCTION OR REHABILITATION OF BUILDING AND FACILITIES is amended as follows:

a. By adding the following paragraph B.:

"B. With respect to any construction or rehabilitation of buildings or facilities performed by the Contractor within the continental limits of the United States under the provisions of paragraph A(5) of PART I of this SCHEDULE, the following shall apply:

(1) Rates of Wages

(a) The minimum wages to be paid laborers and mechanics on this project, as determined by the Secretary of Labor to be prevailing for the corresponding classes of laborers and mechanics employed on projects of a character similar to the contract work in the pertinent locality, are as set forth below:

(b) Any class of laborers and mechanics not listed below which will be employed on this contract shall be classified or reclassified conformably to the schedule set out below by mutual agreement between the Contractor and class of labor concerned subject to the prior approval of the Contracting Officer. In the event the interested parties cannot agree on the proper classification or reclassification of a particular class of laborers and mechanics to be used, the question, accompanied by the recommendation of the Contracting Officer, shall be referred to the Secretary of Labor for final determination.

(c) The latest wage determination made by the Secretary of Labor for the county in which the work is being performed is included herein as Appendix "A". The complete determination is incorporated in the contract specifications regardless of whether the Contractor will employ all of the classes of laborers and mechanics listed."

FIFTH: Effective 1 August 1955, Clause 7 - DISPUTES of the General Provisions is deleted in its entirety and the following substituted therefor:

"7. DISPUTES - Except as otherwise provided in this contract, any dispute concerning a question of fact arising under this contract which is not disposed of by agreement shall be decided by the Contracting Officer, who shall reduce his decision to writing

and mail or otherwise furnish a copy thereof to the Contractor. Within thirty (30) days from date of receipt of such copy, the Contractor may appeal by mailing or otherwise furnishing to the Contracting Officer a written appeal addressed to the Secretary, and the decision of the Secretary or his duly authorized representative for the hearing of such appeals shall, unless determined by a court of competent jurisdiction to have been fraudulent or capricious or arbitrary, or so grossly erroneous as necessarily to imply bad faith, or not supported by substantial evidence, be final and conclusive; provided that, if no such appeal is taken, the decision of the Contracting Officer shall be final and conclusive. In connection with any appeal proceeding under this clause, the Contractor shall be afforded an opportunity to be heard and to offer evidence in support of its appeal. Pending final decision of a dispute hereunder, the Contractor shall proceed diligently with the performance of the contract and in accordance with the Contracting Officer's decision."

SIXTH: Effective 1 August 1955, Clause 8. - NOTICE AND ASSISTANCE REGARDING PATENT INFRINGEMENT, is deleted in its entirety and the following substituted therefor:

"8. NOTICE AND ASSISTANCE REGARDING PATENT INFRINGEMENT. - The provisions of this clause shall be applicable only if the amount of this contract is in excess of $5,000.

(a) The Contractor shall report to the Contracting Officer, promptly and in reasonable written detail, each notice or claim of patent infringement based on the performance of this contract of which the Contractor has knowledge.

(b) In the event of litigation against the Government on account of any claim of patent infringement arising out of the performance of this contract or out of the use of any supplies furnished or work or services performed hereunder, the Contractor shall furnish to the Government, upon request, all evidence and information in possession of the Contractor pertaining to such litigation. Such evidence and information shall be furnished at the expense of the Government except in those cases in which the Contractor has agreed to indemnify the Government against the claim being asserted.

SEVENTH: Effective 1 August 1955, Clause 11, "NONDISCRIMINATION IN EMPLOYMENT", is deleted in its entirety and the following substituted therefor:

"11. NONDISCRIMINATION IN EMPLOYMENT -

(a) In connection with the performance of work under this contract, the Contractor agrees not to discriminate against any employee or applicant for employment because of race, religion, color, or national origin. The aforesaid provision shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post hereafter in conspicuous places, available for employees and applicants for employment, notices to be provided by the Contracting Officer setting forth the provisions of the non-discrimination clause.

(b) The Contractor further agrees to insert the foregoing provision in all subcontracts hereunder, except subcontracts for standard commercial supplies or raw materials."

EIGHTH: Effective 1 August 1955, Clause 16, "REPORTING OF ROYALTIES", is deleted in its entirety and the following substituted therefor:

"16. REPORTING OF ROYALTIES - The provisions of this clause shall be applicable only if the amount of the contract is in excess of $10,000.

(a) The Contractor shall report in writing (in quadruplicate) to the Contracting Officer as soon as practicable after execution of this contract whether or not any royalties in excess of $250 have been paid or are to be paid by the Contractor directly to any person or firm in connection with the performance of this contract. If royalties in excess of $250 have been paid or are to be paid by any person or firm, the report shall include the following items of information with respect to such royalties (including the initial $250):

(1) The name and address of each licensor to whom royalties in excess of $250 have been paid or are to be paid,

(2) The patent numbers, patent application serial numbers (with filing dates), or other identification of the basis for such royalties.

(3) The manner of computing the royalties consisting of (i) a brief identification of each royalty-bearing unit or process, (ii) the total amount of royalties, and (iii) the percentage rate or dollars and cents amount of royalties on each such unit or process, provided that if the royalties cannot be computed in terms of units or dollars and cents value, then other data showing the manner in which the Contractor computes the royalties.

(b) In lieu of furnishing a report under paragraph (a), the Contractor may furnish a single, consolidated report for each accounting period of the Contractor during which the Contractor has contracts with the Government, provided the Contractor has requested and obtained the prior written approval of the Chief, Patents Division, Office of the Judge Advocate General. Such consolidated report shall be furnished, when the furnishing thereof has been approved, in the number of copies as approved, as soon as practicable after the close of the accounting period covered by the report. Such consolidated report shall be made in accordance with Contractor's established accounting practice and shall include, for the accounting period, the total amount of royalties accruing to each licensor at a rate in excess of $1,000 per annum on the Contractor's over-all business, together with (i) the name and address of each such licensor, (ii) the patent numbers, patent application serial numbers (with filing dates), or other identification of the basis for such royalties, (iii) a brief description of the subject matter of the license under which royalties are charged, (iv) the percentage rate or unit amount, or if the royalties do not accrue by rate or unit amount, such other data showing the manner by which the royalties accrue to licensor, and (v) an estimate or approximation (without detailed accounting) of the portion of such royalties that may be attributable to Government contracts. The Contractor shall, if requested by the Government furnish at Government expense a more detailed allocation of such royalty payments attributable to Government contracts.

(c) In the event that the Contractor requests written approval to furnish consolidated reports under paragraph (b) above, the Chief, Patents Division, Office of the Judge Advocate General shall promptly consider the request and furnish to the Contractor a letter stating whether or not the request

is approved and, notwithstanding any such approval, the Contracting Officer shall have the right to question any such subsequently furnished report as to accuracy or completeness of data and to ask for additional information. The Contractor shall furnish a copy of such letter of approval to the Contracting Officer administering this contract.

(d) After payment of eighty percent (80%) of the amount of this contract, as from time to time amended, further payment shall be withheld until a reserve of either (i) ten percent (10%) of such amount or (ii) $5,000, which ever is less, shall have been set aside, such reserve or the balance thereof to be retained until the Contractor shall have furnished to the Contracting Officer the report called for by paragraph (a) hereof or the copy of the letter approving the Contractor's request to furnish the report under paragraph (b); provided that no amount shall continue to be withheld from payment for the causes specified in this paragraph (d) if the Contracting Officer shall find that the Contractor has not been furnished a letter as required by paragraph (c) within a reasonable time after making written request to submit a single, consolidated report under the provisions of paragraph (b) of this clause; and provided further that the Contracting Officer may, in his discretion, order payment to be withheld in the amount and manner above provided if the report called for by paragraph (a) is unsatisfactory or if the Chief, Patents Division, Office of the Judge Advocate General notifies the Contracting Officer that the report called for by paragraph (b) is due but has not been received, or if received, is found to be unsatisfactory. No amount shall be withheld under this paragraph when the minimum amount specified by this paragraph is being withheld under other provisions of this contract. The withholding of any amount or subsequent payment thereof to the Contractor shall not be construed as a waiver of any right accruing to the Government under this contract.

NINTH: Effective 1 August 1955, Clause 18, REPRODUCTION RIGHTS, is deleted in its entirety and the following Clause 18, REPRODUCTION AND USE OF TECHNICAL DATA, is substituted therefor:

"18. REPRODUCTION AND USE OF TECHNICAL DATA. - The Contractor agrees to and does hereby grant to the Government, to the full extent of the Contractor's right to do so without payment of compensation to others, the right to reproduce, use, and disclose for governmental purposes (including the right to give to foreign governments for their use as the national interest of the United States may demand) all or any part of the reports, drawings, blueprints, data, and technical information specified to be delivered by the Contractor to the Government under this contract; provided however, that nothing contained in this paragraph shall be deemed, directly or by implication, to grant any license under any patent now or hereafter issued or to grant any right to reproduce anything else called for by this contract."

TENTH: Effective 1 August 1955, Clause 26, - RENEGOTIATION of the General Provisions and paragraph 2. RENEGOTIATION of Supplemental Agreement Number 2 (54 768) to this contract are deleted in their entireties

and the following Clause 26 is substituted therefor:

"26. RENEGOTIATION -

(a) This contract shall be subject to any act of the Congress whether heretofore or hereafter enacted and to the extent indicated therein, providing for the renegotiation of said contract and shall be deemed to contain all the provisions required by any such act without subsequent amendment of this contract specifically incorporating such provisions.

(b) The Contractor (which term, as used in this clause, means the party contracting to furnish the materials or perform the work required by this contract) agrees to insert the provisions of this clause, including this paragraph (b), in subcontracts, as defined in Section 103 (g) of the Renegotiation Act of 1951, (Pub. Law 9, 82nd Cong.), except any subcontracts of a class or type, described in Section 106 (a) of the Renegotiation Act of 1951.

(c) Nothing contained in this clause shall impose any renegotiation obligation with respect to this contract or any subcontract hereunder which is not imposed by an act of the Congress, heretofore or hereafter enacted.

ELEVENTH: Effective 1 August 1955, Clause 30, PATENT RIGHTS, is deleted in its entirety and Clause 30, "PATENT RIGHTS", attached hereto, is substituted therefor.

TWELFTH: Effective 1 August 1955, Clause 32, "FILING OF PATENT APPLICATIONS", is deleted in its entirety and the following substituted therefor:

"32. FILING OF PATENT APPLICATIONS -

(a) Before filing or causing to be filed a patent application disclosing any subject matter of this contract, which subject matter is classified "Secret" or higher, the Contractor shall, citing the thirty (30) day provision below, transmit the proposed application to the Contracting Officer for determination whether, for reasons of national security, such application should be placed under an order of secrecy or sealed in accordance with the provisions of 35 U. S. Code 181-188 or the issuance of a patent should be otherwise delayed under pertinent statutes or regulations; and the Contractor shall observe any instructions of the Contracting Officer with respect to the manner of delivery of the patent application to the U. S. Patent Office for filing, but the Contractor shall not be denied the right to file such patent application. If the Contracting Officer shall not have given any such instructions within thirty (30) days from the date of mailing or other transmittal of the proposed application, the Contractor may file the application.

(b) The Contractor shall furnish to the Contracting Officer, at the time of or prior to the time when the Contractor files or causes to be filed a patent application disclosing any subject matter of this contract, which subject matter is

classified "Confidential", a copy of such application for determination whether, for reasons of national security, such application should be placed under an order of secrecy or the issuance of a patent should be otherwise delayed under pertinent statutes or regulations.

(c) In filing any patent application coming within the scope of this clause, the Contractor shall observe all applicable security regulations covering the transmission of classified subject matter.

THIRTEENTH: Effective 1 August 1955, Clause 33, "PATENT INDEMNITY", is deleted in its entirety and the following substituted therefor:

"33. PATENT INDEMNITY (Not Predetermined). - If the amount of this contract is in excess of $5,000, the Contractor shall indemnify the Government and its officers, agents, and employees against liability, including costs, for infringement of any United States letters patent (except letters patent issued upon an application which is now or may hereafter be kept secret or otherwise withheld from issue by order of the Government) arising out of the manufacture or delivery of supplies or component parts thereof, or out of construction, alteration, modification, or repair of real property (hereinafter referred to as "construction work") under this contract, or out of the use or disposal by or for the account of the Government, of such supplies, construction work, or component parts thereof, which supplies or component parts either normally are or have been sold or offered for sale to, and which construction work normally is of a type performed for, the public in the commercial open market by any supplier on or before the date set for opening of bids, or are such supplies, construction work, or component parts thereof, with relatively minor modifications made thereto. The foregoing indemnity shall not apply unless the Contractor shall have been informed as soon as practicable by the Government of the suit or action alleging such infringement, and shall have been given such opportunity as is afforded by applicable laws, rules, or regulations to participate in the defense thereof; and further, such indemnity shall not apply if: (i) the infringement results from compliance with specific written instructions of the Contracting Officer directing a change in the supplies to be delivered or in the materials or equipment to be used, or directing a manner of performance of the contract not normally used by the Contractor; or (ii) the infringement results from addition to or change in, such supplies or components furnished or construction work performed which addition or change was made subsequent to delivery or performance by the Contractor; or (iii) the claimed infringement is settled without the consent of the Contractor, unless required by final decree of a court of competent jurisdiction.

FOURTEENTH: Effective 1 August 1955, Clause 35 "AUTHORIZATION AND CONSENT", is deleted in its entirety and the following substituted therefor:

"35. AUTHORIZATION AND CONSENT. - The Government hereby gives its authorization and consent for all use and manufacture of any patented invention in the performance of this contract or any part hereof or any amendment hereto or any subcontract hereunder (including any lower tier contract)."

FIFTEENTH: Effective 1 August 1955, Clause 40 - CONTRACTUAL CONTENTS of the General Provisions is deleted in its entirety and the following substituted therefor:

"This contract consists of the Preface on Page i, the SCHEDULE containing Parts I through VII, the General Provisions containing Clauses 1 through 47, the signature page, Revised Technical Exhibit I, DD Form 254, and Appendix A attached hereto."

SIXTEENTH: The following clauses are herewith added to the General Provisions for application to work performed within the Continental limits of the United States under PART VI of the SCHEDULE only:

a. "42. DAVIS-BACON ACT (40 USC 276a-276a-7) (Applicable to projects costing $2,000.00 or more only)

(a) All mechanics and laborers employed or working directly upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by the Copeland Act) ("Anti-Kickback") Regulations (29 CFR, Part 3) the full amounts due at time of payment, computed at wage rates not less than those contained in the wage determination decision of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor or subcontractor and such laborers and mechanics; and a copy of the wage determination decision shall be kept posted by the Contractor at the site of the work in a prominent place where it can be easily seen by the workers.

(b) In the event it is found by the Contracting Officer that any laborer or mechanic employed by the Contractor or any subcontractor directly on the site of the work covered by this contract has been or is being paid at a rate of wages less than the rate of wages required by paragraph (a) of this clause, the Contracting Officer may (1) by written notice to the Government prime Contractor terminate his right to proceed with the work, or such part of the work as to which there has been a failure to pay said required wages, and (2) prosecute the work to completion by contract or otherwise, whereupon such Contractor and his sureties shall be liable to the Government for any excess costs occasioned the Government thereby.

(c) Paragraphs (a) and (b) of this clause shall apply to this contract to the extent that it is (1) a prime contract with the Government subject to the Davis-Bacon Act or (2) a subcontract under such prime contract.

b. "43. APPRENTICES - Apprentices will be permitted to work only

(a) Payroll records will be maintained during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records will contain the name and address of each such employee, his correct classification, rate of pay, daily and weekly number of hours worked, deductions made and actual wages paid. The Contractor will make his employment records available for inspection by authorized representatives of the Contracting Officer and the U. S. Department of Labor, and will permit such representatives to interview employees during working hours on the job.

(b) A certified copy of all payrolls will be submitted weekly to the Contracting Officer. The Government Prime Contractor will be responsible for the submission of certified copies of the payrolls of all subcontractors. The certification will affirm that the payrolls are correct and complete, that the wage rates contained therein are not less than the applicable rates contained in the wage determination decision of the Secretary of Labor attached to this contract, and that the classifications set forth for each laborer or mechanic conform with the work he performed.

SEVENTEENTH: Revised Technical Exhibit "I" is amended as follows:

a. By deleting the word "will" appearing in the last line of paragraph 3, Section III, REPAIR AND MAINTENANCE OF EQUIPMENT AND PROPERTY and substituting in lieu thereof the word "may".

b. By adding the following paragraph 4 to Section IV - SUPPORT OPERATIONS.

"4. The Contractor will operate a government furnished vessel or vessels to support, logistically, satellite station sites of the missile test range."

c. By deleting paragraph 2, Section VI - GOVERNMENT FURNISHED EQUIPMENT AND SERVICES in its entirety and substituting the following therefor:

"2. The Government will furnish such MSTS transport as may be required to perform this contract."

d. By deleting paragraph 2 of Section VII - REDSTONE MISSILE PROJECT in its entirety effective 1 August 1955.

EIGHTEENTH: REVISED TECHNICAL EXHIBIT "II" dated 30 June 1954 is deleted in its entirety effective 1 August 1955.

2. This supplemental agreement shall be subject to the written approval of the Secretary of the Air Force or his duly authorized representative and shall not be binding until so approved.

RDP 71-220
1 Aug 51

3. Nothing herein contained shall be deemed to require the Contractor to manufac furnish or deliver any articles or supplies or to perform any work as to which a Notice of Termination is in effect at the effective date of this Supplemental Agre ment nor to require the Government to accept any such articles, supplies or work as any such Notice of Termination shall be applicable to the extent stated therein to any articles, supplies or work called for by this Supplemental Agreement or other wise referred to in this Supplemental Agreement.

4. Except as hereby modified, either expressly or by necessary implication, all the terms, covenants and conditions of the contract affected shall continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

WITNESSES

By /s/ D.N. YATES

/t/ D.N. YATES, Major General, USAF
(Contracting Officer)

PAN AMERICAN WORLD AIRWAYS, INC.
(Contractor)

NOTE: In case of corporation, witnesses not required but certificate below must be completed. Type or print names under all signatures.

By /s/ FRANKLIN GLEDHILL
/t/ Franklin Gledhill
Vice President
(Title)

135 East 42nd Street
Chrysler Building
New York 17, New York
(Address)

NOTE: Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

CERTIFICATE

I, H. Preston Morris, certify that I am the Secretary of the corporation named as Contractor herein; that Franklin Gledhill, who signed this Supplemental Agreement on behalf of the Contractor, was then a Vice President of said corporation; that said Supplemental Agreement was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

/s/ H. PRESTON MORRIS (CORPORATE SEAL)
(SIGNATURE)

30. PATENT RIGHTS.—(a) As used in this clause, the following terms shall have the meanings set forth below:

(i) The term "Subject Invention" means any invention, improvement or discovery (whether or not patentable) conceived or first actually reduced to practice either (A) in the performance of the experimental, developmental, or research work called for or required under this contract, or (B) in the performance of any experimental, developmental, or research work relating to the subject matter of this contract which was done upon an understanding in writing that a contract would be awarded; provided that the term "Subject Invention" shall not include any invention which is specifically identified and listed in the Schedule for the purpose of excluding it from the license granted by this clause.

(ii) The term "Technical Personnel" means any person employed by or working under contract with the Contractor (other than a subcontractor whose responsibilities with respect to rights accruing to the Government in inventions arising under subcontracts are set forth in paragraphs (g), (h), and (i) of this clause) who, by reason of the nature of his duties in connection with the performance of this contract, would reasonably be expected to make inventions.

(iii) The terms "subcontract" and "subcontractor" mean any subcontract or subcontractor of the Contractor, and any lower-tier subcontract or subcontractor under this contract.

(b) The Contractor agrees to and does hereby grant to the Government an irrevocable, nonexclusive, nontransferable, and royalty-free license to practice, and cause to be practiced by or for the United States Government throughout the world, each Subject Invention in the manufacture, use and disposition according to law, of any article or material, and in the use of any method; provided, however, that with respect to (i) any Subject Invention made by other than Technical Personnel, (ii) any Subject Invention conceived prior to, but first actually reduced to practice in the course of, any of the experimental, developmental, or research work specified in paragraph (a)(i) above, and (iii) the practice of any Subject Invention in foreign countries, the obligation of the Contractor to grant the aforesaid license and the other rights hereinafter provided in this clause shall be limited to the extent of the Contractor's right to grant the same without incurring any obligation to pay royalties or other compensation to others solely on account of said grant. No license granted herein shall convey any right to the Government to manufacture, have manufactured, or use any Subject Invention for the purpose of providing services or supplies to the general public in competition with the Contractor or the Contractor's commercial licensees in the licensed fields. Nothing contained in this paragraph shall be deemed to grant any license under any invention other than a Subject Invention.

(c) The Contractor shall:

(i) Make a written disclosure to the Contracting Officer promptly after conception or first actual reduction to practice of each Subject Invention which reasonably appears to be patentable;

(ii) Certify to the Contracting Officer not less often than every twelve months, commencing with the date of this contract, whether or not any Subject Inventions were conceived or first actually reduced to practice during the preceding twelve months; and

(iii) Prior to final settlement of this contract, make a summary report of all those Subject Inventions previously disclosed and of those Subject Inventions conceived or first actually reduced to practice after the last certification but prior to the summary report.

(d) The Contractor shall also in connection with each Subject Invention referred to in paragraph (c)(i) above:

(i) Specify, at the time of making written disclosure, whether or not a United States Patent application claiming such Invention has been or will be filed by or on behalf of the Contractor. If the Contractor specifies that a United States patent application will be filed claiming such Invention, the Contractor shall file or cause to be filed such application in due form and time. If the Contractor decides not to file or cause to be filed said application after having specified that it would file, the Contractor shall so notify the Contracting Officer at the earliest practicable date and in any event not later than eight months after first publication, public use or sale;

(ii) In the event the Contractor specifies that it has not filed and will not file (or having specified that it will file, thereafter notifies the Contracting Officer to the contrary), (A) inform the Contracting Officer in writing at the earliest practicable date of any publication of such Invention made by or known to the Contractor or, where applicable, of any contemplated publication by the Contractor, stating the date and identity of such publication or contemplated publication, and (B) convey to the Government the Contractor's entire right, title and interest in such Invention by delivering to the Contracting Officer upon written request such duly executed instruments (prepared by the Government) of assignment, application and other papers as are deemed necessary to vest in the Government the Contractor's right, title and interest aforesaid, and the right to apply for and prosecute patent applications covering such Invention throughout the world, subject, however, to the right reserved to the Contractor in paragraph (e) to file foreign applications, and subject further to the reservation of a nonexclusive and royalty-free license to the Contractor (and to its existing and future associated and affiliated companies, if any, within the corporate structure of which the Contractor is a part) which license shall be assignable to the successor of that part of the Contractor's business to which the Subject Invention pertains;

(iii) Furnish promptly to the Contracting Officer on request an irrevocable power of attorney to inspect and make copies of each United States patent application filed by or on behalf of the Contractor covering any Subject Invention;

(iv) In the event the Contractor, or those deriving rights from the Contractor, elects not to continue prosecution of any such United States patent application filed by or on behalf of the Contractor, so notify the Contracting Officer not less than sixty days before the expiration of the response period and, upon written request, deliver to the Contracting Officer such duly executed instruments (prepared by the Government) as are deemed necessary to vest in the Government the Contractor's entire right, title and interest in the Subject Invention and the application, subject to the reservations as specified in (ii) above; and

(v) Deliver to the Contracting Officer duly executed instruments fully confirmatory of any license rights herein agreed to be granted to the Government.

(e) The Contractor, or those deriving rights from the Contractor, has the option of filing patent applications in foreign countries on Subject Inventions. If this option is not exercised in the time and manner set forth below, the Government shall have the right to file applications in each foreign country in which the Contractor has not exercised its option.

(i) In the event that the Contractor specifies under the provisions of paragraph (d) that it has not filed and will not file a United States patent application (or having specified that it will file, thereafter notifies the

Contracting Officer to the contrary) the Contractor shall have six months from the date of making the written disclosure required by paragraph (c)(i) to file foreign patent applications.

(ii) In the event that a United States patent application is filed by or on behalf of the Contractor under the provisions of paragraph (d), the Contractor shall have six months from the date of the United States application, or six months from the date permission is granted to file foreign applications where such filing had been prohibited for security reasons, within which to file foreign patent applications. With respect to each Subject Invention on which it has specified that a United States patent application has been or will be filed by or on behalf of the Contractor, the Contractor shall (A) inform the Contracting Officer in writing of each foreign patent application for such Invention filed by or on behalf of the Contractor within six months after the filing by the Contractor of the corresponding United States application, and, if practicable, prior to the publication of the Subject Invention in any country, (B) inform the Contracting Officer in writing at the earliest practicable date of any publication of the Subject Invention made by or known to the Contractor or, where applicable, of any contemplated publication by the Contractor, stating the date and identity of such publication or contemplated publication, (C) upon written request of the Contracting Officer, convey to the Government the Contractor's entire right, title, and interest in such Invention in those countries in which the Contractor has not, within six months after the filing of the corresponding United States application, filed foreign patent applications, and deliver to the Contracting Officer, upon written request, such duly executed instruments (prepared by the Government) of assignment, application, and other papers as are deemed necessary to vest in the Government the Contractor's right, title, and interest as aforesaid and the right to apply for and maintain patents covering such invention, subject, however, to the reservation of a nonexclusive and royalty-free license to the Contractor (and to its existing and future associated and affiliated companies, if any, within the corporate structure of which the Contractor is a part) which license shall be assignable to the successor of that part of the Contractor's business to which the Subject Invention pertains, and (D) in the event that the Contractor, or those deriving rights from the Contractor, elects not to continue the prosecution of any foreign application which has been filed by or on behalf of the Contractor, or elects not to maintain any patent granted on such application, so notify the Contracting Officer not less than ninety days before the expiration of the response period or patent lapse date and, upon written request, deliver to the Contracting Officer such duly executed instruments (prepared by the Government) as will convey to the Government the Contractor's entire right, title, and interest in the application or patent, subject to a reservation as specified in (C) above.

(f) If the Contractor fails to deliver to the Contracting Officer the certificates required by paragraph (e)(ii) of this clause or fails to furnish the written disclosures for all Subject Inventions required by paragraph (e)(i) of this clause shown to be due in accordance with any certificate delivered under paragraph (e)(ii), there shall be withheld from payment until the Contractor shall have corrected such failures either (i) ten percent (10%) of the amount of this contract, as from time to time amended, or (ii) $5,000, whichever is less. After payment of eighty percent (80%) of the amount of this contract, as from time to time amended, payment shall be withheld until a reserve of either (i) ten percent (10%) of such amount, or (ii) $5,000, whichever amount is less, shall have been set aside, such reserve or balance thereof to be retained until the Contractor shall have furnished to the Contracting Officer (A) the summary report required by paragraph (e)(iii) of this clause, (B) written disclosures for all Subject Inventions required by paragraph (e)(i) of this clause which are shown to be due in accordance with certificates delivered under paragraph (e)(ii) or in accordance with such summary report, and (C) the information as to any subcontractor required by paragraph (h) of this clause. The maximum amount which may be withheld under this paragraph shall not exceed ten percent (10%) of the amount of this contract or $5,000, whichever is less, and no amount shall be withheld under this paragraph when the minimum amount specified by this paragraph is being withheld under other provisions of this contract. The withholding of any amount or subsequent payment thereof to the Contractor shall not be construed as a waiver of any rights accruing to the Government under this contract. This paragraph shall not be construed as requiring the Contractor to withhold any amounts from a subcontractor to enforce compliance with the patent provisions of a subcontract.

(g) The Contractor shall exert all reasonable effort to negotiate for the inclusion of this Patent Rights clause in any subcontract hereunder of $3,000 or more having experimental, developmental, or research work as one of its purposes. In the event of refusal by a subcontractor to accept the Patent Rights clause, the Contractor shall not proceed with the subcontract without written authorization of the Contracting Officer, and upon obtaining such authorization, shall cooperate with the Government in the negotiation with such subcontractor of an acceptable patent rights clause; provided, however, that the Contractor shall in any event require the subcontractor to grant to the Government patent rights under Subject Inventions of no less scope and on no less favorable terms than those which the Contractor has under such subcontracts, except that in no event shall the subcontractor be required to grant to the Government patent rights in excess of those herein agreed to be granted to the Government by the Contractor.

(h) The Contractor shall, at the earliest practicable date, notify the Contracting Officer in writing of any subcontract containing a patent rights clause, furnish the Contracting Officer a copy of such clause and notify the Contracting Officer when such subcontract is completed. It is understood that with respect to such subcontract clause, the Government is a third party beneficiary; and the Contractor hereby assigns to the Government all the rights that the Contractor would have to enforce the subcontractor's obligations for the benefit of the Government with respect to Subject Inventions. The Contractor shall not be obligated to enforce the agreements of any subcontractor hereunder relating to Subject Inventions.

(i) When the Contractor shows that it has been delayed in the performance of this contract by reason of its inability to obtain in accordance with paragraph (g) a suitable patent rights clause from a qualified subcontractor for any item or service required under this contract for which the Contractor itself does not have available facilities or qualified personnel, the Contractor's delivery dates shall be extended for a period of time equal to the duration of such delay; and, upon request of the Contractor, the Contracting Officer shall determine to what extent, if any, an additional extension of the delivery dates and an increase in contract prices based upon additional costs incurred by such delay are proper under the circumstances; and the contract shall be modified accordingly. If the Contractor, after exerting all reasonable effort, is unable to obtain a qualified subcontractor as set forth above, the Contractor may submit to the Contracting Officer a written request for waiver or modification of the requirement that a suitable patent rights clause be included in the subcontract. Such request shall specifically state that the Contractor has used all reasonable effort to obtain such qualified subcontractor, and shall cite the waiver or termination provision hereinafter set forth. If, within thirty-five (35) days after the date of receipt of such request for a waiver or modification of said requirement, the Contracting Officer shall fail to deny in writing such request, the requirement shall be deemed to have been waived by the Government. If within such period the Contractor shall receive a written denial of such request by the Contracting Officer, this contract shall thereupon automatically terminate and the rights and obligations of the parties shall be governed by the provisions of the clause of this contract entitled "Termination for the Convenience of the Government."

CONTRACT NO. AF 18(600)-881

APPENDIX "A"
RATE OF WAGES

PREDETERMINATION NO. 0-15,334 DATE OF PREDETERMINATION 29 JUNE 1955

EXPIRATION DATE OF PREDETERMINATION 28 SEPT.1955

The latest wage determination made by the Secretary of Labor for the county in which the work is being performed is included herein. The complete determination is incorporated in the contract specifications regardless of whether the Contractor will employ all of the classes of laborers and mechanics listed.

CLASSIFICATION OF LABORERS AND MECHANICS AND MINIMUM RATES OF WAGE PER HOUR

Asbestos workers	$2.85	Painters swing stage	$2.50
" " improvers:		Plumbers	2.90
1st year	1.425	Steamfitters	2.90
2nd "	1.71	Roofers, built-up	2.475
3rd "	1.995	Sheet metal workers	2.95
4th "	2.28	Soft floor layers	2.25
Boilermakers - Blacksmiths	2.975	Sprinkler fitters	2.83
" " Helpers	2.725	Truck drivers under 3 tons	1.00
Bricklayers	2.75	" " over 3 tons	1.25
Stone masons	2.75	Power equipment operators:	
Terrazzo workers	2.75	Oiler - crawler type equipment	1.625
Tile setters	2.75	Mechanic Helper	1.625
Plasterers	2.75	Oiler - truck crane	1.76
Cement masons	2.75	Air compressor	1.79
Cement block layers	2.75	Pumpman	1.79
Carpenters	2.50	Fireman	1.90
Millwrights	2.75	Tractor Operator	2.04
Piledrivers	2.75	Concrete mixer under 10 sacks	2.04
Electricians (wiremen)	2.90	Concrete mixer over 10 sacks	2.45
Electricians (Linemen)	2.90	Bulldozer operator	2.04
Cable splicers	2.90	Mechanics	2.45
Groundmen	1.50	Pump crete operator	2.45
Elevator Constructors	2.86	Hoist operator	2.45
" helpers	2.00	Clamshell operator	2.45
Glaziers	1.85	Dragline operator	2.45
Ironworkers, structural	2.75	Pile driver operator	2.45
" ornamental	2.75	Shovel operator	2.45
" reinforcing	2.50	Hook crane operator:	
Air tool operator	1.25	1. When erecting steel or miscellaneous iron	2.76
Laborers	1.15	2. All other work	2.615
Mason tenders	1.25	Side boom cat operator	2.515
Mortar mixers	1.25	Bridge crane operator	2.515
Plasterers tenders	1.25	Barbergreen	2.35
Painters, brush	2.25	Front end loader	2.20
" spray (subject to practice prevailing in area)	2.75	Motor patrol	2.20
" structural steel	2.50	Compressor plant	2.20
Winch truck	2.20	Roller operator	1.95
Marble masons	2.75	Well point	2.05

Welders - Receive rate prescribed for craft performing operation to which welding is incidental.

		Apprentice Schedule Period and Rate									
Craft	Interval	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Sprinkler fitters	6 mos	54	58	62	66	70	74	78	82	86	90
Electricians	6 mos	$1.30	$1.40	after 1st year 1.50							
"	year		1.50	1.65	1.95	2.10					
Ironworkers	6 mos	50	60								
"	year		66-2/3								
Roofers	year	$1.375	1.515	1.65	1.925						
Sheet metal workers	6 mos	40	45	50	55	60	65	70	80		
Plumbers and steamfitters	6 mos	$ .95	1.28								
"	year		1.62	1.98	2.15	2.33					
Carpenters	year	$1.50	1.75	2.00	2.25						
Linemen	year	$1.50	1.65	1.95	2.10						

The apprentice rate is by percentage of the journeymen's rate unless otherwise indicated.

SUPPLEMENTAL AGREEMENT NO.	6
to Contract No.	AF 04([illegible])-691
Classification	Unclassified
PR	MIPR-55-2
Initiator	W. A. [illegible], MTR
Buyer	E. I. [illegible], MTR
E. O. No.	None

SUPPLEMENTAL AGREEMENT
TO
[illegible]
for
SERVICES

DEPARTMENT OF THE AIR FORCE
(United States Air Force)

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.

SUPPLEMENTAL AGREEMENT FOR: INCREASE IN FUNDS

CHANGE IN ESTIMATED COST: $180,000.00 (INCREASE)

CHANGE IN FIXED FEE: NONE

Payments to be made by the Finance Office, hq Air Force Missile Test Center, Patrick Air Force Base, Florida

The supplies and services, if any, to be obtained by this instrument are authorized by, are for the purpose set forth in, and are chargeable to the allotments below enumerated under the heading "Debit", the available balances of which are sufficient to cover the cost thereof. The reduction, if any, in estimated cost or fixed fee under this instrument will result in credits to the allotments below enumerated under the heading "Credit".

DEBIT: 57X1400 0[illegible] P[illegible]-67 306-00
PR No. MTR-55-2 $[illegible]2,000.00

57X1400 5[illegible]-0308 P[illegible]-67 306-00
PR No. MTR-55-2 $ 2[illegible],000.00

ADMINISTRATIVE OFFICE: Headquarters Air Force Missile Test Center
Patrick Air Force Base, Florida

This negotiated Supplemental Agreement is entered into pursuant to authority of Section 2(c)(1) of the Armed Services Procurement Act of 1947, as amended by the 83rd Congress, and any required determination and findings have been made.

S/A 6 to 881

11 July 1955

TO: PAN AMERICAN WORLD AIRWAYS, INC.
135 East 42nd Street
Chrysler Building
New York 17, New York

SUBJECT: INCREASE IN FUNDS

CHANGE IN ESTIMATED COST: $186,000.00 (Increase)

CHANGE IN FIXED FEE: NONE

1. The subject contract as amended, is hereby further amended in the following particulars:

FIRST: By amending PART III, CONSIDERATION AND PAYMENT of the Schedule as follows:

a. By increasing the estimated cost set forth in sub-paragraph A(1) by the sum of ONE HUNDRED EIGHTY-SIX THOUSAND DOLLARS AND NO CENTS ($186,000.00), thereby making the total estimated cost for the contract SIXTEEN MILLION FIVE HUNDRED SIXTY-SEVEN THOUSAND FOUR HUNDRED SIXTY DOLLARS AND NO CENTS ($16,567,460.00).

b. By increasing the amount allotted for the contract as set forth in sub-paragraph A(3) by the sum of ONE HUNDRED EIGHTY-SIX THOUSAND DOLLARS AND NO CENTS ($186,000.00), thereby making the total amount allotted SEVENTEEN MILLION TWO HUNDRED TWENTY-TWO THOUSAND FOUR HUNDRED SIXTY DOLLARS AND NO CENTS ($17,222,460.00).

Page 2

II. Nothing herein contained shall be deemed to require the Contractor to manufacture, furnish or deliver any articles or supplies or to perform any work as to which a Notice of Termination is in effect at the effective date of this Supplemental Agreement nor to require the Government to accept any such articles, supplies or work and any such Notice of Termination shall be applicable to the extent stated therein to any articles, supplies or work called for by this Supplemental Agreement or otherwise referred to in this Supplemental Agreement.

III. Except as hereby modified, either expressly or by necessary implication, all the terms, covenants and conditions of the contract affected shall continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

WITNESS

By /S/ D. N. YATES

/T/ D. N. Yates, Maj. Gen., USAF
(Contracting Officer)

PAN AMERICAN WORLD AIRWAYS, INC
(Contractor)

NOTE: In case of corporation, witnesses not required but certificate below must be completed. Type or print names under all signatures.

By /S/ FRANKLIN GLEDHILL

Vice President
(Title)

135 East 42nd Street (Chrysler Bldg.)
New York 17, New York
(Address)

NOTE: Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

CERTIFICATE

I, H. Preston Morris certify that I am the Secretary of the corporation named as Contractor herein; that Franklin Gledhill, who signed this Supplemental Agreement on behalf of the Contractor, was then A Vice President of said corporation; that said Supplemental Agreement was duly signed for and in behalf of said corporation by authority of its governing body, and is within the [illegible] powers

/S/ H. PRESTON MORRIS (SEAL)

Page 2 of Supplemental Agreement No. [illegible]

RDF 71-22B
1 Aug 51

SUPPLEMENTAL AGREEMENT NO.	5
to Contract No.	AF 18(600)-881
Classification	Unclassified
PR	S-55-446, FP-9(55)-143 and MTR-55-1
Initiator	B. A. SUSTARE, MTEMC
Buyer	B. A. SUSTARE, MTEMC
E. O. No.	None

SUPPLEMENTAL AGREEMENT
TO
COST-PLUS-A-FIXED-FEE CONTRACT
for
SERVICES

DEPARTMENT OF THE AIR FORCE
(United States Air Force)

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.

SUPPLEMENTAL AGREEMENT FOR: CHANGES IN SPECIFICATIONS FOR WORK AND NET DECREASE IN FUNDS

CHANGE IN ESTIMATED COST: $145,000.00 (DECREASE)

CHANGE IN FIXED FEE: NONE

Payments to be made by the Finance Office, Hq Air Force Missile Test Center, Patrick Air Force Base, Florida

The supplies and services, if any, to be obtained by this instrument are authorized by, are for the purpose set forth in, and are chargeable to the allotments below enumerated under the heading "Debit", the available balances of which are sufficient to cover the cost thereof. The reduction, if any, in estimated cost and fixed fee under this instrument will result in credits to the allotments below enumerated under the heading "Credit".

DEBIT: Paragraph 2 (b) of Section IV of Technical Exhibit "I" (For period 1 July 1954 through 30 June 1955 except that with respect to Cape Canaveral AAFB the period shall commence on 1 March 1955) chargeable to: 5753500 047-5008 551-08 S0 8-606 PR No. S-55-446 $ 88,000.00

Paragraph 4 of Section V of Technical Exhibit "I" (Installation of Instrumentation by sub-sub-contract only) chargeable to:
57X3600 547-5008 P680-07 S08-606 PR No. FP-9(55)-143 $153,000.00

57X3600 547-5008 P690-07 S08-606 PR No. MTR-55-1 $ 66,000.00

CREDIT: 5753400 047-5008 P468-07 S08-606 $452,000.00
Adm. Notice No. 3-212 dated 18 March 1955 and PR MTR-55-1

ADMINISTRATIVE OFFICE: Headquarters Air Force Missile Test Center
Patrick Air Force Base, Florida

This negotiated Supplemental Agreement is entered into pursuant to the provisions of Section 2(c)(1) of the Armed Services Procurement Act of 1947 (Public Law 413, 80th Congress), and any required determination and findings have been made.

24 June 1955

SUBJECT: CHANGE IN SPECIFICATIONS FOR WORK AND DECREASE IN FUNDS

CHANGE IN ESTIMATED COST: $145,000.00 (Decrease)

CHANGE IN FIXED FEE: NONE

1. The subject contract as amended, is hereby further amended and supplemented in the following particulars:

FIRST: By amending Part III Consideration and Payment of the Schedule as follows:

a. By decreasing the Estimated Cost set forth in sub-paragraph A(1) by the sum of ONE HUNDRED FORTY-FIVE THOUSAND DOLLARS AND NO CENTS ($145,000.00), thereby making the total Estimated Cost for the contract SIXTEEN MILLION THREE HUNDRED EIGHTY-ONE THOUSAND FOUR HUNDRED SIXTY DOLLARS AND NO CENTS ($16,381,460.00).

b. By decreasing the amount allotted for the contract as set forth in sub-paragraph A(3) by the sum of ONE HUNDRED FORTY-FIVE THOUSAND DOLLARS AND NO CENTS ($145,000.00) thereby making the total amount allotted SEVENTEEN MILLION THIRTY SIX THOUSAND FOUR HUNDRED SIXTY DOLLARS AND NO CENTS ($17,036,460.00).

SECOND: By amending Revised Technical Exhibit "I" dated 31 July 1954 as follows:

a. By redesignation of paragraph 2 of Section IV as sub-paragraph 2(a).

b. By adding the following sub-paragraph 2(b) to Section IV:

" (b) Messing of Enlisted Personnel of the U. S. Armed Forces as may be authorized by the Contracting Officer under the provisions of this Section IV, to the extent that charges are made to subsistence funds specifically allotted to this contract for that purpose, shall be at predetermined rates per meal established by the Contracting Officer."

. Nothing herein contained shall be deemed to require the Contractor to manufacture, furnish or deliver any articles or supplies or to perform any work as to which a Notice of Termination is in effect at the effective date of this Supplemental Agreement not to require the Government to accept any such articles, supplies or work and any such Notice of Termination shall be applicable to the extent stated therein to any articles, supplies or work called for by this Supplemental Agreement or otherwise referred to in this Supplemental Agreement.

. Except as hereby modified, either expressly or by necessary implication, all the terms, covenants and conditions of the contract affected shall continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

WITNESSES

By /S/ D. N. YATES

D. N. YATES, Maj Gen, USAF
(Contracting Officer)

PAN AMERICAN WORLD AIRWAYS, INC
(Contractor)

NOTE: In case of corporation, witnesses not required but certificate below must be completed. Type or print names under all signatures.

By PAN AMERICAN WORLD AIRWAYS, INC

/S/ J. C. LESLIE
(Title)

/S/ J. C. LESLIE
Vice President
135 East 42nd Street, (Chrysler Bldg)
New York 17, New York
(Address)

NOTE: Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

C E R T I F I C A T E

I, H. Preston Morris certify that I am the Secretary of the corporation named as Contractor herein; that J. C. Leslie, who signed this Supplemental Agreement on behalf of the Contractor, was then Vice President of said corporation; that said Supplemental Agreement was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

/S/ H. PRESTON MORRIS (CORPORATE SEAL)
(SIGNATURE)

1 Aug 51

Supplemental Agreement No. 4 (55-624)
to Contract No. AF 18(600)-881

Classification NONE

PR NONE

HHH/mfs

Initiator H. H. HUBER, RDSKR

Buyer H. H. HUBER, RDSKR

E. O. No. NONE

SUPPLEMENTAL AGREEMENT
TO
COST-PLUS-A-FIXED-FEE CONTRACT
for

SERVICES

DEPARTMENT OF THE AIR FORCE

(UNITED STATES AIR FORCE)

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.

SUPPLEMENTAL AGREEMENT FOR: ADDITIONAL WORK, CHANGES IN SPECIFICATIONS FOR WORK, AND NET DECREASE IN FUNDS

CHANGE IN ESTIMATED COST: $580,000.00 - (DECREASE)

CHANGE IN FIXED FEE: NONE

Payments to be made by the Finance Officer, Hq., Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Florida.

The supplies and services, if any, to be obtained by this instrument are authorized by, are for the purpose set forth in, and are chargeable to the allotments below enumerated under the heading "Debit", the available balances of which are sufficient to cover the cost thereof. The reduction, if any, in estimated cost and fixed fee under this instrument will result in credits to the allotments below enumerated under the heading "Credit".

CREDIT: 5753400 547-5008 P468-07 S08-606 $520,000.00
57x3600 547-5008 P690-07 S08-606 $100,000.00
Administrative Notice No. 2-181, dated 4 February 1955
DEBIT: 57x3600 547-5008 P680-07 S08-606 $ 40,000.00
O. A. 55-37

Administrative Office: Headquarters, Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Florida

This negotiated Supplemental Agreement is entered into pursuant to the provisions of Section 2 (c) (1) of the Armed Services Procurement Act of 1947 (Public Law 413, 80th Congress), and any required determination and findings have been made.

60

10 February 1955

TO: PAN AMERICAN WORLD AIRWAYS, INC.
135 East 42nd Street
Chrysler Building
New York 17, New York

SUBJECT: ADDITIONAL WORK, CHANGES IN SPECIFICATIONS FOR WORK, AND NET DECREASE IN FUNDS

CHANGE IN ESTIMATED COSTS: $580,000.00 -- (DECREASE)

CHANGE IN FIXED FEE: NONE

I. The subject contract, as amended, is hereby further amended and supplemented in the following particulars which affect Supplemental Agreement No. 2.

FIRST: By amending the Administrative Recitals on the cover page as follows:

a. By amending the allotment reference appearing on Supplemental Agreement No. 2(55-768) as cited for MIPR R-55-1-ORDDDW-RD to read as follows:

"21X2040 505-4213 P5512 S01-021 (90A 111).
MIPR-R-55-1-ORDDDW-RD."

SECOND: By amending paragraph B. of PART I - STATEMENT OF WORK - to read as follows:

"B. For the purposes of this contract, the Missile Test Range of the Air Force Missile Test Center shall mean the existing facilities at, or hereafter furnished by the Government for (a) the Technical Systems Laboratory, including the photographic laboratory, data reduction center, and electronics and optical maintenance shops at Patrick Air Force Base and (b) the Auxiliary Air Force Bases and satellite station sites of said Test Range. The Auxiliary Air Force Bases shall mean: (1) Cape Canaveral AAFB, (2) Jupiter AAFB, (3) Grand Bahama AAFB, (4) Eleuthera AAFB, (5) San Salvador AAFB, (6) Mayaguana AAFB, (7) Grand Turk AAFB, (8) Dominican AAFB, (9) Mayaguez AAFB, Puerto Rico, (10) Saint Lucia AAFB, and (12)(Classified). Satellite station sites shall include, but not be limited to, Walker Cay Station No. 3B, Little Carter Cay, and Pensacola/Allen Cay. Auxiliary Air Force Base No. 12 (Classified) and additional satellite station sites, as required, shall be designated to the Contractor by the Contracting Officer or set forth elsewhere in this contract or amendments hereto."

THIRD: By amending PART III - CONSIDERATION AND PAYMENT - of the Schedule as follows:

a. By reason of action taken in Administrative Notice No. 2-181, dated 4 February 1955, releasing excess funds to this contract, the following decreases are effected hereby:

(1) The total estimated cost set forth in paragraph a under the SECOND particular of Supplemental Agreement No. 3 is decreased

by the sum of SIX HUNDRED TWENTY THOUSAND DOLLARS AND NO CENTS ($620,000.00).

(2) The total amount allotted in paragraph b under the SECOND particular of Supplemental Agreement No. 3 is decreased by the sum of SIX HUNDRED TWENTY THOUSAND DOLLARS AND NO CENTS $620,000.00).

b. By reason of the additional items of work set forth under this Supplemental Agreement No. 4, and as provided for under Obligation Authority No. 55-57, the following increases are effected hereby:

(1) The total estimated cost set forth in paragraph a under the SECOND particular of Supplemental Agreement No. 3 is increased by the sum of FORTY THOUSAND DOLLARS AND NO CENTS ($40,000.00).

(2) The total amount allotted in paragraph b under the SECOND particular of Supplemental Agreement No. 3 is increased by the sum of FORTY THOUSAND DOLLARS AND NO CENTS ($40,000.00).

c. By reason of the actions indicated in a and b above, the following net decreases are effected hereby:

(1) The total estimated cost set forth in paragraph a under the SECOND particular of Supplemental Agreement No. 3 is decreased by the sum of FIVE HUNDRED EIGHTY THOUSAND DOLLARS AND NO CENTS ($580,000.00), thereby making the total estimated cost for the contract SIXTEEN MILLION FIVE HUNDRED TWENTY-SIX THOUSAND FOUR HUNDRED SIXTY DOLLARS AND NO CENTS ($16,526,460.00).

(2) The total amount allotted in paragraph b under the SECOND particular of Supplemental Agreement No. 3 is decreased by the sum of FIVE HUNDRED EIGHTY THOUSAND DOLLARS AND NO CENTS ($580,000.00), thereby making the total amount allotted under the contract SEVENTEEN MILLION ONE HUNDRED EIGHTY-ONE THOUSAND FOUR HUNDRED SIXTY DOLLARS AND NO CENTS ($17,181,460.00).

FOURTH: By amending Revised Technical Exhibit "I", dated 31 July 1954, attached to and made a part of Supplemental Agreement No. 2 hereof, as follows:

a. Deletion of paragraph 1. of SECTION IV - SUPPORT OPERATIONS in its entirety and substitution of the following therefor:

"1. The Contractor shall provide all such base level support of supplies and services as are required, pursuant to this contract, for the management, operation, and maintenance of the Missile Test Range, utilizing facilities and related equipment furnished under this contract. In addition, the Contractor shall furnish such necessary base level support on the Missile Test Range and Patrick Air Force Base as is required for personnel, other than the Contractors' or Sub-Contractors' employees, as authorized or approved by the Contracting Officer."

b. Addition of the following paragraph 3. to SECTION IV - SUPPORT OPERATIONS as follows:

"3. The Contractor will provide electronic provisioning and cataloging services for the AFMTC, to include but not necessarily be limited to, the following:

a. Establish initial requirements and initiate procurement of replacement parts for all electronic equipment and test equipment used on the Missile Test Range; such requirements to be submitted for approval prior to initiation of procurement action.

b. Establish records and data cards to allow for subsequent utilization of material as may result from engineering changes and/or equipment modifications with the least loss of material.

c. Maintain in a current status all presently prepared parts lists as well as those to be produced.

d. Prepare requests when required for NL stock numbers in accordance with current AF procedures.

e. Reproduce, assemble, and distribute to all users replacement part catalogues for all electronic equipment used on the Missile Test Range.

c. By deleting paragraph 4. SECTION V - RANGE ENGINEERING - in its entirety and substituting the following in lieu thereof:

"4. The contractor will perform, such in-house development, installation of instrumentation, and non-standard equipment fabrication as is directed or approved by the Contracting Officer. Such in-house development by the Contractor will be limited, in general, to minor modifications or equipment improvement effort."

d. Addition of the following paragraph 11. to SECTION V - RANGE ENGINEERING:

"11. The Contractor shall be responsible for the maintenance of airborne electronic equipment (airborne instrumentation) utilized to support range test activities. (This maintenance responsibility is not intended to include standard radio communication and navigation equipment with which military aircraft are normally equipped.) As requested, the Contractor shall assist in the installation of such airborne instrumentation, and assist in training of military technician-operators in maintaining their proficiency."

e. Deletion of paragraph 5. of SECTION VI - GOVERNMENT FURNISHED EQUIPMENT AND SERVICES in its entirety and substitution of the following therefor:

"5. Any modification of aircraft incident to tests will be accomplished by the Government at Patrick Air Force Base."

f. Deletion of paragraphs 1a. of SECTION VII - REDSTONE MISSILE PROJECT in its entirety and substitution of the following therefor:

"1a. Phase I - The Contractor shall acquire, assemble, and install terminal flight path instrumentation, for the Redstone Missile Project, to be located at Grand Bahama AAFB, Walker Cay Station No. 3B, Little Carter Cay, and Pensacola/Allen Cay."

g. Deletion of paragraph 2. of SECTION VII - REDSTONE MISSILE PROJECT in its entirety and substitution of the following therefor:

"2. The Contractor shall perform these services called for in this Section VII, during the period 15 July 1954 through 15 December 1955, Phase I beginning on 15 July 1954 and completed by 30 March 1955; Phase II beginning on 31 March 1955 and completed by 15 December 1955."

FIFTH: REVISED TECHNICAL EXHIBIT "II"

a. By adding the following after "Jupiter" on Page 4.

	(April)	(May)	(June)	(July)
"Dominican AAFB		20	25	"30
"Mayaguez AAFB	5	5	10	10
"Saint Lucia AAFB				10"

HSR/MFR/ct

Supplemental Agreement No. 1(55-352)
to Contract No. AF 18(600)-881

Classification None

PR None

Initiator H. H. HUBER, HSKR

Buyer H. H. HUBER, HSKR

R. O. No. None

SUPPLEMENTAL AGREEMENT
TO
COST-PLUS-A-FIXED-FEE CONTRACT
for

SERVICES

DEPARTMENT OF THE AIR FORCE

(UNITED STATES AIR FORCE)

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.

SUPPLEMENTAL AGREEMENT FOR: CHANGES IN ADMINISTRATIVE RECITALS AND DECREASE IN FUNDS

CHANGE IN ESTIMATED COST: $ 71,196.00 - (DECREASE)

CHANGE IN FIXED FEE: NONE

Payments to be made by the Finance Officer, Hqs, Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Florida

The supplies and services, if any, to be obtained by this instrument are authorized by, are for the purpose set forth in, and are chargeable to the allotments below enumerated under the heading "Debit", the available balances of which are sufficient to cover the cost thereof. The reduction, if any, in estimated cost and fixed fee under this instrument will result in credits to the allotments below enumerated under the heading "Credit".

CREDIT: 57X3600 547-5008 P690-07 808-606

P. R. No. 298240 - Obligation Authority Advice No. 55-30

DEBIT: NONE

Administrative Office: Headquarters, Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Florida

This negotiated Supplemental Agreement is entered into pursuant to the provisions [redacted] of the Armed Services Procurement Act of 1947 (Public Law 413, 80th Congress), and [redacted] the basic contract

TO: Pan American World Airways, Inc.
135 East 42nd Street
Chrysler Building
New York 17, New York

24 September 1954

SUBJECT: CHANGES IN ADMINISTRATIVE RECITALS AND DECREASE IN FUNDS

CHANGE IN ESTIMATED COST: $71,196.00 - (DECREASE)

CHANGE IN FIXED FEE: NONE

1. The subject Contract, as amended, is hereby further amended and supplemented in the following particulars which affect Supplemental Agreement No. 2.

FIRST: By amending the Administrative Recitals on the cover page as follows:

a) By decreasing the estimated cost by SEVENTY ONE THOUSAND ONE HUNDRED NINETY SIX DOLLARS AND NO CENTS ($71,196.00) with no change in the fixed fee.

b) By changing the first allotment reference to read "Sections I, III and IV and paragraph 8 of Section II of Technical Exhibit "I" and Fixed Fee Chargeable to: 5753400 047-5008 P468-07 308-606."

c) By changing the second allotment reference to read "Section II (except paragraph 8 thereof) and Section V (except paragraph 10 thereof) of Technical Exhibit "I" chargeable to:"

d) By changing the third allotment reference to read "Paragraph No. 10 of Section V of Technical Exhibit "I" chargeable to:"

SECOND: By amending PART III - CONSIDERATION AND PAYMENT of the Schedule as follows:

a) The total estimated cost set forth in paragraph e) (1) under the *THIRD particular of Supplemental Agreement No. 2 is* decreased by the sum of SEVENTY ONE THOUSAND ONE HUNDRED NINETY SIX DOLLARS AND NO CENTS ($71,196.00) thereby making the total estimated cost for the contract SEVENTEEN MILLION ONE HUNDRED SIX THOUSAND FOUR HUNDRED SIXTY DOLLARS AND NO CENTS ($17,106,460.00)

b) The total amount allotted in paragraph e) (3) under the THIRD PARTICULAR of Supplemental Agreement No. 2 is decreased by the sum of SEVENTY ONE THOUSAND ONE HUNDRED NINETY SIX DOLLARS AND NO CENTS ($71,196.00) thereby making the total amount allotted under the contract SEVENTEEN MILLION SEVEN HUNDRED SIXTY ONE THOUSAND FOUR HUNDRED SIXTY DOLLARS AND NO CENTS ($17,761,460.00).

II Nothing herein contained shall be deemed to require the Contractor to manufacture, furnish or deliver any articles or supplies or to perform any work as to which a Notice of Termination is in effect at the effective date of this Supplemental Agreement nor to require the Government by consent any such articles, supplies or work and any such Notice of Termination shall be applicable to the added items thereto by any articles, supplies or work called for by this Supplemental Agreement or otherwise referred to in this Supplemental Agreement.

III Except as hereby modified, either expressly or by necessary implication, all the terms, covenants and conditions of the contract affected shall continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

By /s/ John R. Martin

JOHN R. MARTIN, Colonel, USAF

WITNESSES

PAN AMERICAN WORLD AIRWAYS, INC.

By /s/ Franklin Gledhill

NOTE—In case of corporation, witnesses not required but certificate below must be completed. Type or print names under all signatures.

Franklin Gledhill

Vice President

135 East 42nd Street (Chrysler Bldg.)
New York 17, New York

NOTE—Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

CERTIFICATE

I, H. Preston Morris, certify that I am the Secretary of the corporation named as Contractor herein; that Franklin Gledhill, who signed this Supplemental Agreement on behalf of the Contractor, was then a vice president of said corporation; that said Supplemental Agreement was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

/s/ H. Preston Morris (CORPORATE SEAL)

Page 2 of Supplemental Agreement No. 3 to Contract No. AF 18(600)-881

Supplemental Agreement No. 2(54-768)
to Contract AF 18(600)-881

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.
Chrysler Building
135 East 42nd Street
New York 17, New York

SUBJECT SUPPLEMENTAL AGREEMENT IS APPROVED.

X
X
X
X
X
X
X
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X
X
X

APPROVED 26 July 1954

JOSEPH F. O'MARAH
Lt Colonel, USAF
Deputy Director of Procurement

Supplemental Agreement No. 2(54 768)
to Contract AF 18(600)-881

HHH/ls

PR 298231 and 298240

MIPR NO. R-55-1-ORDDW-RD, dated 9 July '54
and Amendment No. 1 dated 9 July '54

BUYER: JOHN R. MARTIN, Colonel USAF, RDSI

SUPPLEMENTAL AGREEMENT TO COST-PLUS-A-FIXED-FEE CONTRACT FOR SERVICES

DEPARTMENT OF THE AIR FORCE

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.

SUPPLEMENTAL AGREEMENT FOR: ADDITIONAL WORK AND EXTENSION OF TIME

CHANGE IN ESTIMATED COST: $13,237,703.00 - (Increase)

CHANGE IN FIXED FEE: $ 440,000.00 - (Increase)

Payments to be made by the Finance Officer, Hqs, Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Florida

Administrative Office: Headquarters, Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Florida

DEBIT ALLOTMENT NO'S:

Section I, III and IV of Technical Exhibit "I" and Fixed Fee
Chargeable to: 57534400 547-5008 P468-07 S08-606 . . . . . $7,193,106.00
PR No. 298240 - Obligation Authority Advice No. 55-31

Section II and V (Except paragraph 10 of V) of Technical Exhibit "I"
Chargeable to: 57X3600 547-5008 P690-07 S08-606 . . . . . $6,019,477.00
PR No. 298240 - Obligation Authority Advice No. 55-30

Paragraph No. 10 of Section V of Technical Exhibit "I" and Fixed Fee
Chargeable to: 57X3600 447-3008 P680-07 S08-606 . . . . . $ 302,694.00
PR No. 298231 - Obligation Authority Advice No. 54-44

Section VII of Technical Exhibit "I" and Fixed Fee
Chargeable to: 21X2040 505-4213 P5515 S01-021 SOA 106 . . . . $ 162,426.00
MIPR R-55-1-ORDDW-RD

CREDIT ALLOTMENT NO'S:

57434400 447-3008 P468-07 S08-606 . . . . . $ 250,000.00
57X3600 447-3008 P692-07 S08-606 . . . . . $ 650,000.00
R.E.F. 1-88 dated 17 June 1954

This negotiated Supplemental Agreement is entered into pursuant to the provisions of Section 2(c)(1) of the Armed Services Procurement Act of 1947 (Public Law 413, 80th Congress), and any required determination and findings have been made.

30 June 1954

TO: PAN AMERICAN WORLD AIRWAYS, INC.
135 East 42nd Street
Chrysler Building
New York 17, New York

SUBJECT: ADDITIONAL WORK AND EXTENSION OF TIME

CHANGE IN ESTIMATED COST: $13,237,703.00 - (INCREASE)

CHANGE IN FIXED FEE: 440,000.00 - (INCREASE)

1. The subject contract, as amended, is hereby further amended and supplemented in the following particulars:

FIRST: PART I - STATEMENT OF WORK of the SCHEDULE is amended as follows:

a) By adding to paragraph B, Auxiliary Air Force Bases (10) (Classified) and (12) (Classified), as designated to the Contractor by the Contracting Officer, and Walker Cay Station No. 3B.

b) Technical Exhibit "I" attached to and made a part of the basic contract is hereby superseded as of 31 July 1954 and the Revised Technical Exhibit "I", dated 31 July 1954, attached hereto is made a part of the contract.

c) By deleting paragraph D. in its entirety and substituting the following therefor:

"D. The work required in paragraph A. above shall be performed during the period set forth in PART II hereof, however, operational status of the Missile Test Range, as defined in paragraph B. above, shall be accomplished by the Contractor in accordance with Revised Technical Exhibit "II", dated 30 June 1954, except that decelerations may be directed by the Contracting Officer."

SECOND: PART II - TIME OF PERFORMANCE AND DELIVERY INSTRUCTIONS of the SCHEDULE is amended as follows:

a) By extending the period of performance through 31 July 1955, except that the work to be performed under paragraph 10, SECTION V of Revised Technical Exhibit "I" shall commence on 1 May 1954 and shall be completed by 31 October 1955, and the work to be performed under SECTION VII of Revised Technical Exhibit "I" shall commence on 15 July 1954 and shall be completed by 15 December 1955.

b) By deleting the words "by prepaid mail" in the second line of paragraph B.

THIRD: PART III - CONSIDERATION AND PAYMENT of the Schedule is amended as follows:

a) By reason of action taken in R.Y.F. 1-88, dated 17 June 1954, releasing excess funds to this contract, the estimated cost set forth in subparagraph A(1) and the amount allotted to this contract as set forth in subparagraph A.(3) are hereby reduced in the amount of NINE HUNDRED THOUSAND DOLLARS AND NO CENTS, ($900,000.00).

b) By increasing the estimated cost set forth in subparagraph A.(1) by the sum of THIRTEEN MILLION TWO HUNDRED THIRTY-SEVEN THOUSAND SEVEN HUNDRED THREE DOLLARS AND NO CENTS ($13,237,703.00).

c) By increasing the fixed fee set forth in subparagraph A.(2) by the sum of FOUR HUNDRED FORTY THOUSAND DOLLARS AND NO CENTS, ($440,000.00).

d) By increasing the amount allotted for this contract as set forth in subparagraph A.(3) by the sum of THIRTEEN MILLION SIX HUNDRED SEVENTY-SEVEN THOUSAND SEVEN HUNDRED THREE DOLLARS AND NO CENTS ($13,677,703.00).

e) As a result of the foregoing changes, the total amounts for subparagraphs A.(1), (2), and (3) are increased to the following:

(1) Total estimated cost - SEVENTEEN MILLION ONE HUNDRED SEVENTY-SEVEN THOUSAND SIX HUNDRED FIFTY-SIX DOLLARS AND NO CENTS, ($17,177,656.00).

(2) Total fixed fee - SIX HUNDRED FIFTY-FIVE THOUSAND DOLLARS AND NO CENTS, ($655,000.00).

(3) Total amount allotted - SEVENTEEN MILLION EIGHT HUNDRED THIRTY-TWO THOUSAND SIX HUNDRED FIFTY-SIX DOLLARS AND NO CENTS ($17,832,656.00).

f) By amending subparagraph D. to revise the first period, for the purposes of Clauses 4(i) and (j) of the General Provisions, to be from 30 June 1953 through 31 July 1954.

g) By adding subparagraph E. as follows:

"E". The fixed overhead amount contemplated by Clause 4(i) of the General Provisions is THREE HUNDRED NINETY-FIVE THOUSAND DOLLARS AND NO CENTS, ($395,000.00) for the period 1 August 1954 through 31 July 1955, however, it is expressly agreed that no additional overhead amount shall be paid for the work called for under paragraph 10 of Section V and Section VII of REVISED TECHNICAL EXHIBIT "I", which extends beyond the period set forth above.

h) By adding subparagraph F. as follows:

"F. The provisions of Clause 4 of the General Provisions shall be applied to the consideration for the period 30 June 1953 through 31 July 1954, and for any extension thereof as if said period and each such extension were separate contracts."

FOURTH: By deleting technical Exhibit "II" attached to and made a part of the basic contract, and substituting in lieu thereof "Revised Technical Exhibit II", dated 30 June 1954, attached hereto and hereby made a part hereof.

2. RENEGOTIATION. (a) This Supplemental Agreement shall be subject to any act of the Congress, whether heretofore or hereafter enacted and to the extent indicated therein, providing for the renegotiation of said Supplemental Agreement and shall be deemed to contain all the provisions required by any such act without subsequent amendment of this Supplemental Agreement specifically incorporating such provisions.

(b) The Contractor (which term, as used in this clause, means the party contracting to furnish the materials or perform the work required by this Supplemental Agreement agrees to insert the provisions of this clause, including this paragraph (b) in subcontracts as defined in Section 103(G) of the Renegotiation Act of 1951 (P.L. 9, 82nd Congress), except any subcontracts of a class or type described in Section 106(A) of the Renegotiation Act of 1951.

(c) Nothing contained in this clause shall impose any renegotiation obligation with respect to this Supplemental Agreement or any subcontract hereunder which is not imposed by an act of Congress, heretofore or hereafter enacted.

3. This is the definitive Supplemental Agreement contemplated by the Letter Contract, designated Supplemental Agreement No. 1(54-768) to Contract No. AF18(600)-881, issued to the Contractor under date of 28 April 1954, and supersedes said Letter Contract, as amended. Work performed and payments made under said Letter Contract, as amended, shall be deemed to be work performed and payments made under this definitive Supplemental Agreement. The date of the Letter Contract shall govern for determination of the priority status of this Supplemental Agreement. In the event of a conflict between this definitive Supplemental Agreement and said Letter Contract, as amended, this definitive Supplemental Agreement shall prevail.

4. This Supplemental Agreement shall be subject to the written approval of the Secretary of the Air Force or his duly authorized representative, and shall not be binding until so approved.

4. Nothing herein contained shall be deemed to require the Contractor to manufacture, furnish or deliver any articles or supplies or to perform any work as to which a Notice of Termination is in effect at the effective date of this Supplemental Agreement nor to require the Government to accept any such articles, supplies or work and any such Notice of Termination shall be applicable to the extent stated therein to any articles, supplies or work called for by this Supplemental Agreement or otherwise referred to in this Supplemental Agreement.

5. Except as hereby modified, either expressly or by necessary implication, all the terms, covenants and conditions of the contract affected shall continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written:

THE UNITED STATES OF AMERICA

By /s/ John R. Martin, Colonel, USAF

JOHN R. MARTIN, Colonel, USAF
(CONTRACTING OFFICER)

WITNESSES

PAN AMERICAN WORLD AIRWAYS, INC.
(CONTRACTOR)

By /s/ Franklin Gledhill

NOTE—In case of corporation, witnesses not required but certificate below must be completed. Type or print names under all signatures.

FRANKLIN GLEDHILL

Vice President
(TITLE)

135 East 42nd Street (Chrysler Bldg.)
New York 17, New York
(ADDRESS)

NOTE—Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

CERTIFICATE

I, H. Preston Morris, certify that I am the Secretary of the corporation named as Contractor herein; that Franklin Gledhill, who signed this Supplemental Agreement on behalf of the Contractor, was then a Vice President of said corporation; that said Supplemental Agreement was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

/s/ H. Preston Morris (CORPORATE SEAL)
(SIGNATURE)

31 July 1954

REVISED TECHNICAL EXHIBIT "I" TO
SUPPLEMENTAL AGREEMENT NO. 2 to
CONTRACT NO. AF 18(600)-881

SPECIFICATIONS FOR WORK

Description
Management and Administration (Section I)
Range Operations (II)
Repair and Maintenance of Equipment and Property (Section III)
Support Operations (Section IV)
Range Engineering (Section V)
Government Furnished Equipment and Services (Section VI)
Redstone Missile Project (Section VII)

31 July 1954

SECTION I - MANAGEMENT AND ADMINISTRATION

1. The Contractor management will be responsible for:

a. Management, supervision and planning of work under the Contract.

b. Compliance of all contractor personnel and contractor activities with the provisions of international agreements.

c. Compliance of contractor personnel and activities with applicable AFMTC police regulations.

d. Compliance with security requirements set forth in this contract and applicable Air Force and base security directives.

e. Rendering monthly and special reports covering performance, contractual difficulties, personnel, supply and fund utilization, and furnishing information for preparation of the AFMTC budget, all as directed by the Contracting Officer.

f. Compliance with applicable Government regulations covering the care and use of Government property.

g. Deleted.

h. Such planning as is required to implement the expanded contract contemplated for future periods.

i. Operation and maintenance of a combined technical and classified library at the AFMTC.

31 July 1954

SECTION II - RANGE OPERATIONS

1. *The Contractor will study and analyze the test requirements and* formulate operational plans for conduct of the tests to meet test schedules.

2. The Contractor will establish methods and procedures for, and direct reduction of all flight test data for optical and electronic trajectory measuring systems. *The Contractor will prepare data routines for high-speed* digital computer (FLAC), program, direct and perform reduction of all telemetry data, maintain, repair and make modifications of all data reduction equipment and conduct continuous review and research for improved data reduction methods. The Contractor will prepare for publication, data reduction reports as required.

3. The Contractor will provide services for processing and printing of all metric, documentary and engineering film and oscillograph recordings exposed on the range and base. He will provide necessary still and motion photographic service for documentary and technical activities of contractors and the test range.

4. The Contractor will perform the range test control function and will operate all test equipment.

5. The Contractor will collect, reduce and transmit data from test findings.

6. Deleted.

7. The Contractor will maintain and operate ground interference control on the Missile Test Range as directed. AFMTC will maintain and operate airborne interference control aircraft and equipment.

8. The Contractor will recover missiles impacting on land areas within the confines of Cape Canaveral AAFB and, as directed by AFMTC, on land in other areas, Effective 1 May 1954, the Contractor will train personnel and prepare equipment for missile recovery underwater. Effective 1 September 1954, or sooner if directed by the Contracting Officer, the Contractor will recover missiles in less than ten (10) fathoms of water (mean tide), subject to security restrictions as established by AFMTC.

9. The Contractor will operate all weather observation stations located on the Missile Test Range, and will perform rawinsonde and surface observations as required for range operations.

10. The Contractor will operate and maintain the Shoran stations to accomplish the geo-magnetic survey requirements.

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2
to Contract AF 18(600)-881

44988 O—59——6

31 July 1954

SECTION III - REPAIR AND MAINTENANCE OF EQUIPMENT AND PROPERTY

1. The Contractor will, except as otherwise directed by the Contracting Officer, arrange for or perform maintenance of all the property, equipment, and all other Government Furnished Property delivered to and accepted by the Contractor for the purposes of this contract.

2. Maintenance of buildings and roads shall include normal repair and upkeep. The Air Installations Shops at Patrick AFB will be utilized by the Contractor through the work order procedure for maintenance of buildings and roads other than as specified in this subparagraph.

3. The Contractor will maintain non-standard equipment for which the Air Force normally does not have depot maintenance responsibility, except that with respect to commercial type vehicles, the maintenance facilities at Patrick AFB will be utilized to the greatest practicable extent. The Contractor will have, to the same extent as set forth above, maintenance responsibility for commercial type vehicles assigned to other tenant organizations located on the Missile Test Range. On standard Air Force equipment for which the Air Force normally has depot maintenance responsibility, the Contractor will perform organizational and field maintenance. Items on which the Air Force normally has depot maintenance responsibility will be returned to the depot for this maintenance.

4. Utilities, equipment and components of equipment, not repairable at stations, will be returned to AFMTC for repair at no cost to the Contractor. In the event this equipment cannot be scheduled for repair within a time not detrimental to range operations, the Contractor may, upon approval of the Contracting Officer, have such items repaired, the costs in connection with these repairs to be reimbursable under the contract.

5. The Contractor will be permitted to establish requirements, maintain and store spare parts kits for items of equipment of Auxiliary Air Force Bases, such as special optical and electronic gear, generating plants, air-conditioning equipment and specialized motor vehicles; basic kits of small parts to be maintained at the stations where equipment is installed; and more complete kits of lower level usage items and larger units to be stored at PAFB for dispatch to the stations as required.

6. Deleted.

7. The Contractor will train technicians for the maintenance of the submarine cable and cable stations. The Contractor will maintain the submarine cable in less than ten (10) fathoms of water (mean tide), and cable stations as directed by the Contracting Officer.

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2 to
Contract No. AF 18(600)-881

31 July 1954

SECTION IV - SUPPORT OPERATIONS

1. The Contractor shall provide all such base level support of supplies and services as are required, pursuant to this contract, for the management, operation, and maintenance of the Missile Test Range, utilizing facilities and related equipment furnished under this contract. In addition, the Contractor shall furnish such necessary base level support, at the aforementioned Auxiliary Air Force Bases of the Missile Test Range, as is required for personnel, other than the Contractors' or Sub-Contractors' employees, as authorized or approved by the Contracting Officer.

2. For the purposes of this contract, the requirements set forth above shall be applicable to those activities of the Missile Test Range for which operational status is accomplished pursuant to Revised Exhibit "II" to this Supplemental Agreement, but not be limited to messing facilities, security and police and fire protection, bus transport, recreational equipment, first aid, missile fuel storage and handling, ground support for flight operations, operation of liquid oxygen plant and fuel dispensing units, and related services.

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2 to
Contract No. AF 18(600)-811

31 July 1954

SECTION V - RANGE ENGINEERING

1. The Contractor will plan and develop required changes and/or additions, provide installation drawings as required due to changes and/or additions subsequent to the starting date of this contract, make modifications to instrumentation equipment, supervise installation contractors at Patrick Air Force Base, Stations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 and DF sites or picket ships used in lieu of DF sites, to meet missile test requirements.

2. The Contractor will provide technical liaison and monitoring on research and development contracts and perform inspection and acceptance tests on non-standard instrumentation under procurement.

3. The Contractor will prepare technical specifications to be used as the basis for the procurement of required new instrumentation and services.

4. The Contractor will perform such in-house development and non-standard equipment fabrication as is directed or approved by the Contracting Officer. Such in-house development by the Contractor will be limited, in general, to minor modifications or equipment improvement effort.

5. The Contractor will provide essential information on facility requirements to permit the Government to prepare necessary design criteria and budget estimates.

6. The Contractor will plan, initiate procurement of, distribute, calibrate and maintain test equipment for the Test Center.

7. The Contractor will study and analyze the requirements of all test agencies planning to use the Missile Test Range, in terms of range capability to meet these requirements, formulate operational plans for the range based on the requirements of the using agencies. The contractor will schedule the activities to meet the missile test schedules, establish procedures and direct activities to obtain data from which to process and reduce data, and report results of missile flight tests.

8. Deleted.

9. The Contractor will do all land surveys to locate instrumentation that are required on those stations where they have taken over operations.

10. The Contractor will, as more specifically set forth below, (i) provide as-built drawings, for a permanent record, of existing instrumentation installations including communications installations other than administrative telephone systems at the Auxiliary Air Force Bases of the Missile Test Range, AFMTCC: (ii) develope a system for perpetually keeping the record drawings provided under (i) above current; (iii) provide a system of instrumentation cable and wire identification markings; and (iv) furnish and wire markings:

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2 to
Contract No. AF 18(600)-881

31 July 1954

SECTION V - CONTINUED

(a) Under 10(ii) above, the Contractor will devise, and submit for approval, a drawing system plan which when approved by the Contracting Officer, will insure that the as-built drawings are continuously kept current. This plan shall be such that implementation thereof may be accomplished by any commercial contractor or by the AFMTC, whichever is in the best interests of the Government.

(b) All personnel having access to drawings of the complete instrumentation system of a range station must have a Secret Clearance. Personnel having access to drawings of other than complete instrumentation systems must have a Confidential clearance.

(c) All drawings furnished by the Contractor hereunder shall be in pencil on cloth. Drawing titles and numbers shall be developed by the Contractor in coordination with AFMTC. A suitable index shall be furnished by the Contractor for easy identification of the drawing, the instrumentation system, and the range station concerned. Tracings shall be submitted to AFMTC for approval of the Contracting Officer prior to issue. Drawings shall conform to the sizes and format established by AFMTC and directed by the Contracting Officer. Lettering may be done by hand or lettering aids and must be of high professional quality in all respects, and must be of sufficient size to permit clear, sharp, legible reproduction for ease of handling.

(d) All drawings and tracings are to be furnished to the Government as they are completed and approved, and the Contractor shall make any corrections found necessary within six months after completion or termination of this contract by reason of material inaccuracy in any such drawings.

(e) The Contractor will devise a cable and wire marker system for ready identification of all cables and wiring incident to instrumentation installation, and such system shall be reflected on all as-built, isometric, schematic, and wiring drawings or diagrams. Special equipment procured or fabricated by the Contractor for installation of this marker system shall become the property of the Government.

(f) Information will be available to the Contractor in the form of existing drawings, sketches, and instruction books, and through consultation with AFMTC engineers. The Contractor shall obtain, from whatever sources available, additional information necessary to complete the work hereunder. Actual tracing of circuits, measurements on the site, coordination of all available sketches, instruction books, etc., shall be performed by the Contractor. Construction details of buildings will not be required other than building details as directly related to the instrumentation installation features.

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2
to Contract AF 18(600)-881

31 July 1954

SECTION VI - GOVERNMENT FURNISHED EQUIPMENT AND SERVICES

1. The Government will fly, maintain and base aircraft incident to and required to support the Missile Test Range operation.

2. The Government will furnish MSTS transport for all GFE and all other sea transport required to perform this contract.

3. The Air Force will transfer to the Contractor the necessary General Purpose and Special Purpose vehicles approved by the Contracting Officer. The maintenance of vehicles will be accomplished in accordance with AFM 77-1.

4. Deleted.

5. Any instrumentation and/or modification of aircraft incident to tests will be accomplished by the Government at Patrick Air Force Base with technical supervision provided by Contractor.

6. The Government will establish all policies and procedures for providing in-flight safety prior to launching, during flight and termination of flight; evaluate suitability of various in-flight safety devices, circuitry, plotting board charts, sky screens, communications and flight termination systems; approve proposed missile flight plans from a safety standpoint; serve as final authority on missile safety during flight. Government personnel will occupy only those positions requiring decision to launch or terminate flight.

7. Fuels will be delivered by the Government to storage areas. This applies not only to the Cape but to other Auxiliary Air Force Bases. At such bases fuels will be delivered at the beach.

8. Deleted.

9. The Government will supply fire protection and guards for convoys from Patrick Air Force Base to the Cape Canaveral Area.

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2 to
Contract No. AF 18(600)-881

31 July 1954

SECTION VI - (CONTINUED)

10. Bus transport between Patrick AFB and Cape Canaveral will be operated by the Government.

11. Required storeroom space at PAFB to be determined, will be made available to the Contractor for storage of spare parts kits for specialized equipment, vehicles and operating equipment at stations.

12. The Government will furnish additional medical service and ambulance as required by firing schedule at Cape Canaveral.

13. Innoculations for contractor personnel processing for downrange assignment will be provided by the Government at PAFB in accordance with AF Regulations.

14. Special Medical examinations required for contractor personnel, i.e., fuel storage personnel, will be furnished by the Government at PAFB in accordance with AF Regulations.

15. Chemical analysis of special fuel stored at the Cape will be performed by the Government at the PAFB Chemical Laboratory as required.

16. The Government will furnish emergency hospital and medical services for Contractor personnel in accordance with applicable USAF Regulations.

17. Contractor will be provided with a storage area (new building now under construction) adjacent to the TSL for a consolidated service center storeroom for TSL. This storeroom will be used for bench stock expendable items and specialized parts issued by Base Supply and/or procured by the Contractor for use in the TSL Area.

18. The Contractor will draw stock items from Base Supply as required for use or to replenish spare parts kits.

19. The Government will provide necessary office and work space and utilities at PAFB and will provide maintenance, fire protection and security service for such space and the related utilities, and janitor service for administrative space.

20. The Government will furnish commercial electric power to the Contractor at Cape Canaveral.

21. Basic indoctrination of contractor personnel in Test Range mission and downrange briefing will be furnished by the Government.

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2 to
Contract No. AF 18(600)-881

31 July 1954

SECTION VI - (CONTINUED)

22. During FY 1954 USAF will be responsible for weather officer coverage at Cape Canaveral and for planning and launching forecasts for missiles, for operating all required rawinsonde sections, including the one at Patrick AFB, and for taking all surface observations required for missile operations, and providing storm warnings and hurricane warning for all AFMTC Downrange sites. During FY 1955, the USAF will be responsible for operating the base weather station at Patrick AFB and making all forecasts.

23. The Government will furnish normal communication service to the Contractor as may be available at Patrick Air Force Base. The Contractor will reimburse the Government, in accordance with established procedures, for any and all toll, installation, or other communication charges incurred by the Contractor and charged to the account of the Government. Any such charges which are properly allowable items of cost under this contract shall be reimbursed to the Contractor.

24. The Government will retain at Patrick Air Force Base, and make available to the Contractor, all existing specifications, drawings, and technical data relating to Range installations, operation, and maintenance.

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2 to
Contract No. AF 18(600)-881

31 July 1954

SECTION VII - REDSTONE MISSILE PROJECT

1a. Phase I - The Contractor shall acquire, assemble, and install terminal flight path instrumentation, for the Redstone missile project, to be located at Grand Bahama AAFB, Walker Cay Station No. 3B, and one impact area station as directed by the Contracting Officer.

1b. Phase II- The Contractor shall operate and maintain the terminal flight path instrumentation installed under Phase One above.

2. The Contractor shall perform the services called for in this Section VII during the period 15 July 1954 through 15 December 1955, Phase I beginning on 15 July 1954 and completed by 15 December 1954; Phase II beginning on 16 December 1954 and completed by 15 December 1955.

3. Technical direction shall be the responsibility of the Commanding General, Army Redstone Arsenal, through an Army project engineer and/or liaison officer who shall furnish the Contractor all available diagrams, manuals, sketches, and consulting service with Army agencies. The Contractor shall procure from other sources additional information required to complete the Terminal flight path instrumentation system.

REVISED TECHNICAL EXHIBIT "I"
Supplemental Agreement No. 2
to Contract AF 18(600)-881

REVISED TECHNICAL EXHIBIT "II"
30 JUNE 1954
CONTRACT NO. AF18(600)-881

CONTRACTOR PHASE-IN SCHEDULE
RANGE OPERATIONS, AFMTC
CONTRACTOR OPERATIONAL RESPONSIBILITY
PERCENTAGE PHASE-IN

	1953		1954				
FUNCTION	DEC	JAN	FEB	MAR	APR	MAY	JUNE
Management	100						
Planning and Procedures	30	60	90	100			
Contract Administration	100						
Industrial Relations	90	100					
Supply Department	50	75	80	85	90	100	
Accounting Department	40	45	50	55	75	90	100
Plant Engineering						20	30
Cable Terminal Maintenance			20	20	40	80	100
Technical Systems Laboratory	50	75	100				
Optic Machine Shop	50	75	100				
Radar Shop	65	80	100				
Development Shop			100				
Instrument Repair Shop	90	100					
Photo Laboratory	50	75	100				
Data Reduction	60	70	100				
Range Base Administration				10	30	70	100
Cape Canaveral AAFB	50	75	100				
Grand Bahama AAFB				10	50	90	100

FUNCTION	DEC	JAN	FEB	MAR	APR	MAY	JUNE
Eleuthera AAFB						25	*30
San Salvador AAFB						25	*30
Mayaguana AAFB						25	*30
Grand Turk AAFB						25	*30
Jupiter AAFB							*50

*100% Responsibility (Standby Status)

	1954					
FUNCTION	JUL	AUG	SEP	OCT	NOV	DEC
Plant Engineering	50	100				
Eleuthera	*30	30	30	30	30	30
San Salvador	*30	30	30	30	30	30
Mayaguana	*30	30	30	30	30	30
Grand Turk	*30	30	30	30	30	30
Jupiter	*50	50	50	50	50	50
Missile Recovery	50	75	100			
Sub-Cable Maintenance	75	100				
Shoran Operation		25	100			
Technical Library		100				

*100% Responsibility (Stand-By Status)

	1955						
FUNCTION	JAN	FEB	MAR	APR	MAY	JUN	JUL
Eleuthera	*30	30	30	30	30	75	100
San Salvador	*30	30	30	30	30	75	100
Mayaguana	*30	30	30	30	30	75	100
Grand Turk	*30	30	30	30	30	75	100
Jupiter	*50	50	50	50	50	50	50

*100% Responsibility (Standby Status)

RDP 71-328
1 AUG 51

Supplemental Agreement No. 1(54-913)
to Contract No. AF 18(600)-881

Classification None

PR None

HHH/ls

Initiator

Buyer H. H. HUBER, BDSYR

E. O. No. None

SUPPLEMENTAL AGREEMENT
TO
COST-PLUS-A-FIXED-FEE CONTRACT
for

Services

DEPARTMENT OF THE AIR FORCE

(UNITED STATES AIR FORCE)

CONTRACTOR: PAN AMERICAN WORLD AIRWAYS, INC.

SUPPLEMENTAL AGREEMENT FOR: EXTENSION OF TIME

CHANGE IN ESTIMATED COST: NONE

CHANGE IN FIXED FEE: NONE

Payments to be made by the FINANCE OFFICER, HEADQUARTERS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, COCOA, FLORIDA

The supplies and services, if any, to be obtained by this instrument are authorized by, are for the purpose set forth in, and are chargeable to the allotments below enumerated under the heading "Debit", the available balances of which are sufficient to cover the cost thereof. The reduction, if any, in estimated cost and fixed fee under this instrument will result in credits to the allotments below enumerated under the heading "Credit".

CREDIT: NONE

DEBIT: NONE

Administrative Office: HEADQUARTERS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, COCOA, FLORIDA

This negotiated Supplemental Agreement is entered into pursuant to the provisions [redacted] **of the Armed Services Procurement Act of 1947 (Public Law 413, 80th Congress), and** [redacted] the basic contract.

7 June 1954

TO: PAN AMERICAN WORLD AIRWAYS, INC.
135 East 42nd Street
Chrysler Building
New York 17, New York

SUBJECT: EXTENSION OF TIME

PRICE CHANGE: NONE

1. The subject contract, as amended and supplemented, is hereby further amended and supplemented in the following particular:

FIRST: By amending paragraph A of PART II - TIME OF PERFORMANCE AND DELIVERY INSTRUCTIONS, to read as follows: "The Contractor shall perform the services called for herein during the period 30 June 1953 through 31 July 1954."

2. The changes and revisions called for by this Supplemental Agreement do not change the consideration or contract price of the basic contract.

2. Nothing herein contained shall be deemed to require the Contractor to manufacture, furnish or deliver any articles or supplies or to perform any work as to which a Notice of Termination is in effect at the effective date of this Supplemental Agreement nor to require the Government to accept any such articles, supplies or work and any such Notice of Termination shall be applicable to the extent stated therein to any articles, supplies or work called for by this Supplemental Agreement or otherwise referred to in this Supplemental Agreement.

4. Except as hereby modified, either expressly or by necessary implication, all the terms, covenants and conditions of the contract affected shall continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

By /s/ John R. Martin

JOHN R. MARTIN, Colonel, USAF

(CONTRACTING OFFICER)

WITNESSES

/s/ Christine A. Barton

PAN AMERICAN WORLD AIRWAYS, INC.

(CONTRACTOR)

By /s/ Franklin Gledhill

Franklin Gledhill

Vice President

(TITLE)

135 East 42nd Street, Chrysler Building
New York 17, New York

(ADDRESS)

NOTE—In case of corporation, witnesses not required, but certificate below must be completed. Type or print names under all signatures.

NOTE—Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

CERTIFICATE

I, H. Preston Morris, certify that I am the Secretary of the corporation named as Contractor herein; that Franklin Gledhill, who signed this Supplemental Agreement on behalf of the Contractor, was then a Vice President of said corporation; that said Supplemental Agreement was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

/s/ H. Preston Morris (CORPORATE SEAL)

(SIGNATURE)

Page 2 of Supplemental Agreement No. 4 to Contract No. AF 18(600)-881

CONTRACTORS NAME: Pan-American World Airways, Inc. Contract No. AF18(600)-881

ADDRESS: 135 East 42nd Street
Chrysler Building
New York 17, New York

Subject Contract is Approved

X

X

X

X

X

X

X

X

X

X

X

X

X

DATE: 28 January 1954

APPROVED:

/s/ Roger Lewis
Asst. Secretary of the Air Force

44988 O—59——7

DEPARTMENT OF DEFENSE	DEPARTMENT OF THE	CONTRACT NO.
CPFF **NEGOTIATED CONTRACT** HHH/ct	AIR FORCE	AF 18(600)-881

ISSUING OFFICE

NAME	ADDRESS
AIR RESEARCH AND DEVELOPMENT COMMAND	Post Office Box 1395 Baltimore 3, Maryland

CONTRACTOR

NAME	ADDRESS
PAN AMERICAN WORLD AIRWAYS, INC.	135 East 42nd Street Chrysler Building New York 17, New York

CONTRACT FOR	AMOUNT
OPERATION AND MAINTENANCE OF MISSILE TEST RANGE, AFMTC	EST COST: $4,839,953.00 FIXED FEE: 215,000.00 TOTAL $5,054,953.00

APPROPRIATION AND OTHER ADMINISTRATIVE DATA

PURCHASE REQUEST NO'S 298003 And 368963

ALLOTMENT NO'S:

SECTIONS I, III, AND IV OF TECHNICAL EXHIBIT "I" AND FIXED FEE CHARGEABLE TO: 5743400 447-3008 P468-07 S08-606 - - - $2,156,649.00

SECTIONS II AND V OF TECHNICAL EXHIBIT "I" CHARGEABLE TO:

57x3600 347-2008 P692-07 S08-606 - - - - - - - - $ 364,000.00
57x3600 447-3008 P692-07 S08-606 - - - - - - - - $2,534,304.00

CLASS: NONE

INITIATOR: Thomas F. Weldon, Lt. Colonel, USAF, RDMPE

BUYER: John R. Martin, Colonel, USAF, RDMP

DO RATING: C-9 CERTIFIED UNDER DMS REGULATION NO. 1

PAYMENT WILL BE MADE BY THE FINANCE OFFICER, HQS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, COCOA, FLORIDA

ADMINISTRATIVE OFFICE: HQS, AIR FORCE MISSILE TEST CENTER, PATRICK AIR FORCE BASE, COCOA, FLORIDA

This is the Definitive Contract contemplated by Letter Contract dated 30 June '53

This negotiated contract is entered into pursuant to the provisions of Section 2 (c) (1) of the Armed Services Procurement Act of 1947 *(Public Law 413, 80th Congress)*, and any required determination and findings have been made.

THIS CONTRACT is entered into as of 31 December, 19 53, by and between the United States of America, hereinafter called the Government, represented by the Contracting Officer executing this contract, and PAN AMERICAN WORLD AIRWAYS, INC. (NAME OF CONTRACTOR)

(i) a corporation organized and existing under the laws of the State of NEW YORK

hereinafter called the Contractor. The parties hereto agree that the Contractor shall furnish and deliver all the supplies and perform all the services set forth in the attached Schedule, for the consideration stated therein.

DD Form 881 (1 Jun 50)

WHEREAS, the Commander of the Air Force Missile Test Center is charged with the responsibility of operating facilities for the accomplishment of tests and the performance of research and development related to tests, on guided missiles, controlled targets, drones, components and allied equipment; to support operational evaluation and training as directed; and to provide facilities for other governmental agencies and Contractors, in support of the mission of Air Research and Development Command; and,

WHEREAS, in addition to management, operation and maintenance, certain Research and Development and other technical services are required in the accomplishment of this mission; and,

WHEREAS, it is considered desirable to secure such services from private industry; and,

WHEREAS, the Contractor is considered capable of providing or arranging to provide the required scientific, professional or otherwise qualified personnel to assist in the performance of the mission; and,

WHEREAS, a high degree of cooperation and mutual understanding between the contracting parties is a prerequisite to the end that the contract shall be performed as economically and effectively as possible; and

WHEREAS, the Contractor is willing to furnish the services herein provided for under the direction and authority of the Commander, Air Force Missile Test Center; and,

NOW, THEREFORE, in consideration of these covenants and agreements and for other good and valuable considerations, the Contractor shall, under the direction and authority of the Commander, Air Force Missile Test Center, acting through such Contracting Officer as the Commander shall designate, perform the services described in PART I - STATEMENT OF WORK of the Schedule, below:

SCHEDULE	PAGE NO.	NO. OF PAGES
	ii	iv

PART I - STATEMENT OF WORK

A. The Contractor shall furnish the necessary services and materials for the management, operation and maintenance of the Missile Test Range facilities, and related activities of the Air Force Missile Test Center as follows:

(1) Administration, management and planning for (2), (3) and (4) below, with Headquarters at Patrick Air Force Base as set forth in Section I of Technical Exhibit "I" attached hereto;

(2) Operation and maintenance of the Missile Test Range of the Air Force Missile Test Center (AFMTC) for the purpose of acquisition, transmission and reduction of test data as set forth in Sections II and III of Technical Exhibit "I" attached hereto;

(3) Support of the foregoing operations and of users of said Missile Test Range and of personnel at Auxiliary Air Force Bases in said Missile Test Range as set forth in Section IV of Technical Exhibit "I" attached hereto;

(4) Range engineering services as set forth in Section V of Technical Exhibit "I" attached hereto;

B. For the purposes of this contract, the Missile Test Range of the Air Force Missile Test Center shall mean the existing facilities at, or hereafter furnished by the Government for (a) the Technical Systems Laboratory, including the photographic laboratory, data reduction c[illegible], and electronics and optical maintenance shops at Patrick Air Force Base and (b) the Auxiliary Air Force Bases of said Test Range. The Auxiliary Air Force Bases shall mean; (1) Cape Canaveral AAFB, (2) Jupiter AAFB, (3) Grand Bahama AAFB, (4) Eleuthera AAFB, (5) San Salvador AAFB, (6) Mayaguana AAFB, (7) Grand Turk AAFB, (8) Dominican AAFB, and (9) Mayaguez AAFB, Puerto Rico, said Bases being hereinafter sometimes referred to by the numbers indicated.

C. All work shall be accomplished in accordance with the detailed specifications and requirements set forth in Technical Exhibit "I", attached hereto and made a part hereof. Additional work beyond the general scope of this contract and attached Technical Exhibits I and II will be made only by mutual consent of the parties and evidenced by a Supplemental Agreement hereto. Changes requiring additional work within the general scope of this contract and attached Exhibits will be accomplished pursuant to Clause 2, General Provisions.

D. PHASES. The work required in paragraph A above shall be performed substantially in accordance with the following and as more specifically set forth in Technical Exhibit "II", except that deceleration may be directed by the Contracting Officer:

Phase 1. Cape Canaveral AAFB shall be 100% operational by 31 March 1954.

Grand Bahama AAFB shall be 100% operational by 30 June 1954.

Eleuthera AAFB shall be 100% operational by 30 June 1954.

Administration, management and planning specified in A.(1) above shall be 100% operational by 30 June 1954.

DD Form 251-1

SCHEDULE	PAGE NO. 111	NO. OF PAGES iv

The Technical Systems Laboratory, as more specifically set forth in Part I B(a) of the Schedule, shall be 100% operational by 28 February 1954.

Phase II. It is agreed by the parties that accomplishment of operational status for auxiliary Bases other than Cape Canaveral AAFB, Grand Bahama AAFB, and Eleuthera AAFB is subject to availability of funds and agreement of the parties, which shall be evidenced by contractual instrument.

E. Keep adequate records of the activities in the performance of the work called for herein and furnish such reports at such times and places as may be directed by the Contracting Officer.

PART II - TIME OF PERFORMANCE AND DELIVERY INSTRUCTIONS:

A. The Contractor shall perform the services called for herein during the period 30 June 1953 through 30 June 1954.

B. All reports, studies, criteria and other information and material and official communications shall be delivered to the Government by prepaid mail addressed to the Commander, Air Force Missile Test Center, Patrick Air Force Base, Florida, Attention: Administrative Contracting Officer, marked Contract No. AF 18(600)-881, or such other points as may be directed in writing by the Commander, Air Force Missile Test Center.

PART III - CONSIDERATION AND PAYMENT:

A. (1) The estimated cost for this contract as contemplated by Clause 4(a) REIMBURSEMENT, of the General Provisions, is FOUR MILLION EIGHT HUNDRED THIRTY-NINE THOUSAND NINE HUNDRED FIFTY THREE DOLLARS AND NO CENTS ($4,839,953.00).

(2) The fixed fee for this contract contemplated by Clause 4(a) REIMBURSEMENT, of the General Provisions is TWO HUNDRED FIFTEEN THOUSAND DOLLARS AND NO CENTS ($215,000.00).

(3) The amount allotted for this contract as contemplated by Clause 4(c) REIMBURSEMENT, of the General Provisions, is FIVE MILLION FIFTY-FOUR THOUSAND NINE HUNDRED FIFTY-THREE DOLLARS AND NO CENTS ($5,054,953.00).

B. Allowable costs will be determined by the Contracting Officer in accordance with Part 2 of Section XV of the Armed Services Procurement Regulation. It is understood and agreed, without limiting the generality of the foregoing, that the following shall be considered as allowable items of cost, in addition to costs allowable under Clause 4 REIMBURSEMENT, of the General Provisions of this contract, when incurred in the performance of work hereunder:

(1) Cost of travel, living, and other employee-incurred expense, including charge for transfer and relocation (both permanent and temporary) of employees and their families, wages and other benefits to captured or detained employees, all in accordance with the Contractor's Standard Practice Instructions, as may be approved by the Contracting Officer. Contractor's said Instructions may be amended from time to time, subject to the approval of the Contracting Officer.

DD Form 251-1

SCHEDULE	PAGE NO.	NO. OF PAGES
	iv	iv

(2) Cost of Federal, State, Local, Territorial and Foreign taxes and duties which are allocable to this contract (exclusive of Foreign and Federal Income and Excess Profits Taxes) to the extent that exemption therefrom is not available to the Contractor and to the extent that such taxes or duties are not included in any other classification hereunder.

C. Reimbursement under this contract will be made, when requested by the Contractor, based upon provisional audit, it being agreed that any reimbursements made pursuant to this Contract shall be subject to final audit and adjustment prior to final settlement under this contract.

D. The fixed overhead amount covering all overhead indirect costs, contemplated by Clause 4(i) of the General Provisions is $135,396.00. For the purposes of Clause 4(j) REDETERMINATION OF FIXED OVERHEAD AMOUNT, the amount set forth herein shall be redetermined every twelve (12) months. The first period shall be from 30 June 1953 through 30 June 1954. Contractor shall be paid the agreed fixed overhead amount in monthly installments based upon percentage of completion of the work as determined by the Contracting Officer.

PART IV - GOVERNMENT PROPERTY

A. The Government may furnish to the Contractor, for use in connection with the performance of this contract, such Government furnished property as may be approved by the Contracting Officer, and such property shall be delivered to the Contractor in accordance with Clause 20 - GOVERNMENT PROPERTY and/or Clause 21 - ADDITIONAL PROVISIONS CONCERNING GOVERNMENT PROPERTY of the General Provisions of this contract.

PART V - ENGINEERING AND SCIENTIFIC REPORTS, DRAWINGS, BLUEPRINTS, TECHNICAL DATA, ETC.

A. Title to engineering and scientific reports, drawings, blueprints, technical data, bills of material, photograph models, and the like, produced or acquired by the Contractor in the performance of this contract, shall be solely in the Government, and upon completion or termination of this contract all such material shall be delivered to the Government as directed by the Contracting Officer.

PART VI - CONSTRUCTION OR REHABILITATION OF BUILDING AND FACILITIES:

A. The Contractor shall not, without the approval of the Contracting Officer, construct or rehabilitate, or place any sub-contract for the construction or rehabilitation of buildings and facilities.

PART VII - SECURITY:

A. Clause 27 - MILITARY SECURITY REQUIREMENTS of the General Provisions hereto is hereby amended as follows:

Reletter sub-paragraphs (d) and (e) to read (e) and (f) respectively.

Insert the following as sub-paragraph (d):

(d) As security is of an essence of the work under this Contract, and as this operation is, in parts, of a nature affecting the national security, the Contractor agrees to closest coordination with the security agencies of the United States Air Force and further agrees to accept the policies and procedures relative to security as laid down for this particular contract by the United States Air Force and communicated to the Contractor by the Commander, AMC, or the Contracting Officer.

DD Form 561-1
(1 Jun 50)

GENERAL PROV[illegible]S

COST-PLUS-A-FIXED FEE CONTRACT

1. DEFINITIONS. As used throughout this contract, the following terms shall have the meanings set forth below:

(a) The term "Secretary" means the Secretary, the Under Secretary, or any Assistant Secretary of the Department and the head or any assistant head of the executive agency; and the term "his duly authorized representative" means any person or persons or board (other than the Contracting Officer) authorized to act for the Secretary.

(b) The term "Contracting Officer" means the person executing this contract on behalf of the Government and any other officer or civilian employee who is a properly designated Contracting Officer; and the term includes, except as otherwise provided in this contract, the authorized representative of a Contracting Officer acting within the limits of his authority.

(c) Except as otherwise provided in this contract, the term "subcontracts" includes purchase orders under this contract.

2. CHANGES. The Contracting Officer may, at any time, by a written order make changes in or additions to the drawings and specifications, issue additional instructions, require additional work within the general scope of the contract, or direct the omission of work covered by the contract. If such changes cause a material increase or decrease in the amount or character of the work to be done under this contract, or in the time required for its performance, an equitable adjustment of the estimated cost and of the amount of the fixed fee to be paid to the Contractor shall be made and the contract shall be modified in writing accordingly. Any claim by the Contractor for adjustment under this clause must be asserted within thirty (30) days from the date of receipt by the Contractor of the notification of change; provided, however, that the Contracting Officer, if he decides that the facts justify such action, may receive and act upon any such claim asserted at any time prior to final payment under this contract. Failure to agree to any adjustment shall be a dispute concerning a question of fact within the meaning of the clause of this contract entitled "Disputes." However, nothing in this clause shall excuse the Contractor from proceeding with the contract as changed.

3. INSPECTION. All materials and workmanship shall be subject to inspection and test by representatives of the Government. For this purpose, the Contractor shall allow at all times inspectors and other Government personnel, free access to the plant and operations and shall furnish such facilities, supplies and services as may be required for this work.

4. REIMBURSEMENT. (a) The Contractor shall be paid as full compensation for the performance of this contract, the fixed fee specified in the Schedule and the allowable costs of performance of this contract. The estimated cost of performance is stated in the Schedule. Said estimated cost and the fixed fee are subject to increases or decreases as herein provided, but there shall be no adjustment in the amount of the fixed fee because of any errors or omissions in computing said estimated cost, or because the estimated cost varies from the actual cost.

(b) Allowable costs will be determined by the Contracting Officer in accordance with Part 2 of Section XV of the Armed Services Procurement Regulation, it being understood that the premium portion of overtime wage payments shall be allowable hereunder only if and to the extent that the overtime work for which such payments are made has been expressly authorized by the Contracting Officer in writing.

* Duly authorized by the Commander, AF Missile Test Center,

RDP 71-3-(2)
24 Apr 53

(c) The Contractor shall procure materials and services in the manner most advantageous to the Government, price and other factors considered.

(d) The Government will currently reimburse the Contractor for such expenditures made in accordance with this contract as may be approved or ratified by the Contracting Officer and upon certification to and verification by him of the original signed payrolls for labor, the original paid invoices for material, or other original papers. In the event it is impracticable for the Contractor to furnish original signed payrolls for labor, original paid invoices for material or other original papers, Contractor shall furnish evidence in a form acceptable to the Contracting Officer covering expenditures to be reimbursed hereunder. Reimbursement will normally be made weekly, but may be made at other intervals if conditions warrant.

(e) Ninety percent (90%) of the fixed fee set forth in the Schedule, as said fee may be increased or decreased from time to time, shall be paid as it accrues, in monthly installments based upon percentage of completion of the work as determined by the Contracting Officer. Upon completion of the work and its final acceptance any unpaid balance of the fee shall be paid to the Contractor.

(f) As of the date of this contract, there has been allotted for it the sum stated in the Schedule. This sum may be increased from time to time by the Government solely in its discretion. Upon the making of any such increase, the Contracting Officer shall notify the Contractor in writing of the amount thereof.

(g) Notwithstanding any other provisions of this contract the Contractor shall not be bound to take any action in connection with the performance of this contract that would cause the amount for which the Government will be obligated hereunder to exceed the sum allotted for this contract, and the obligation of the Contractor to proceed with the performance of this contract shall be limited accordingly. If at any time the Contractor has reason to believe that the amount to be expended by it in the next succeeding 30 days, when added to all previous expenditures and to the total amount of the Contractor's fixed fee, if any, will exceed 75% of the sum allotted for this contract, it shall notify the Contracting Officer to that effect, giving a new estimate of its total expenditures under this contract, so that an appropriate increase may be made in the sum allotted for this contract. Anything in this contract to the contrary notwithstanding, the Government shall not be obligated to pay to the Contractor either for reimbursement of expenditures or fixed fee or otherwise any amount in excess of the sum allotted for this contract; provided however, that if the Contractor makes any expenditures for which funds are not allotted, the Contracting Officer may ratify such expenditures when funds are allotted.

(h) Any cost incurred by the Contractor under the terms of this contract which would constitute an allowable item or cost under the provisions of paragraph (b) of this clause shall be included in determining the amount payable under this contract, notwithstanding any provisions contained in the specifications or other documents, incorporated in this contract by reference, designating services to be performed or materials to be furnished by the Contractor at its expense or without cost to the Government.

(i) It has been determined by the Contracting Officer, in advance, and agreed to by the contracting parties for the purpose of simplifying auditing procedures applicable hereto, that the amounts set forth in the Schedule represent a reasonable and proper proportionate share of all of Contractor's overhead applicable and allocable to the performance of this contract, and as excluding any expenditures or items of cost for which direct reimbursement is provided elsewhere in this contract. Unless the prior approval of the Contracting Officer is obtained, the Contractor shall not change its method of accounting under this contract in such manner as to account for any item of cost on a direct-cost basis if such item of cost was considered as an indirect charge for the purpose of establishing the overhead amount set forth in the Schedule.

(j) Redetermination of Overhead Amount:

(1) The overhead amount set forth in the Schedule may be increased or decreased in accordance with this clause.

(2) Overhead Periods. The Government and the Contractor agree to revise the fixed overhead amount under this contract periodically in accordance with this clause a' agree the performance of this contract will be divided into successive periods of t. number of months each, set forth in the Schedule after the first period, for that purpose. The first period will extend from the date set forth in the Schedule. The first day of the second period, and each subsequent period, is hereinafter referred to as the "effective date of the overhead amount revision." Within sixty (60) days after the end of the first period hereunder and after the end of each subsequent period, or at such later time or times as the Contracting Officer may fix, the Contractor shall furnish the statements and data referred to in paragraph (3) of this clause.

(3) Submission of Data. At the time or each of the times specified or provided for in paragraph (2) of this clause, the Contractor shall submit (i) a new estimate and breakdown of the overhead amount proposed for the succeeding period under this contract; (ii) an explanation of the differences between the original (or last preceding) overhead amount and the new estimate; (iii) such relevant data, cost records, reports, and accounting statements as may be of assistances in determining the accuracy and reliability of the new estimate; (iv) a statement of experienced overhead costs hereunder to the extent that they are obtainable at the time or times of the negotiation of the revision of the overhead amount; (v) any other relevant data usually furnished in the case of negotiation of a. overhead amount to the extent available. The Government may make such examination of the Contractor's records and books as the Contracting Officer may require and may make such audit thereof as the Contracting Officer may deem necessary.

(4) Upon the filing of the statements and data required by paragraph (3) of this clause, the Contractor and the Contracting Officer will negotiate promptly in good faith to agree upon the overhead amount to be applicable on and after the effective date of the overhead amount revision. Each such revision of the overhead amount shall be fair and reasonable in the circumstances and shall be evidenced by a supplemental agreement hereto.

(5) Disagreements. If within ninety (90) days after the effective date of the overhead amount revision (or such further period as may be fixed by written agreement) the Contracting Officer and the Contractor fail to agree to a revised overhead amount for the period in question, the failure to agree shall be deemed to be a disagreement as to a question of fact which shall be disposed of in accordance with the clause hereof entitled "Disputes."

(6) Payments. Until a new overhead amount shall become effective in accordance with this clause, the overhead amount in force immediately prior to the effective date of the overhead amount revision shall be applicable, subject to appropriate later revision made pursuant to paragraph (4) or (5) or (7) (b)1 of this clause.

(7) Termination Provisions. For any of the purposes of the clause hereof entitled "Termination for Convenience of the Government," the fixed overhead amount or allowance shall be deemed to be:

(a) For expenditures made prior to the effective date of the overhead amount revision, the fixed overhead amount (giving effect to any prior revisions under this clause) applicable to such expenditures;

(b) for all expenditures made on or after the effective date of the overhead amount revision,

1 the overhead amount as revised in accordance with this clause if such revision shall have been agreed upon; and

2 if such revision shall not have been agreed upon, then such overhead amount as the Contractor and the Contracting Officer may agree upon as reasonable under all the circumstances, and in the absence of such agreement such reasonable overhead amount as may be determined in accordance with the clause hereof entitled "Disputes."

(8) The Contractor shall not be paid any overhead with respect to any divisions, departments, burden centers, etc., other than those for which fixed overhead amounts have been specifically set forth herein, without the approval of the Contracting Officer. After such approval the parties agree to promptly negotiate such additional fixed overhead amount as may be required, and such additional amounts shall be evidenced by a supplemental agreement hereto (which may be the supplemental agreement establishing revised amounts hereunder), and shall thereafter be subject to the provisions hereinabove set forth.

(9) In the event that an accelerated Government program involving either new procurement or the acceleration of delivery or performance schedules on existing procurements becomes effective as to the Contractor during any of the overhead amount periods, the overhead amounts established for such period shall be subject to review and revision by negotiation upon written demand made by either party. Any increase or decrease in the overhead amounts established as a result of such review and revision shall be set forth in an amendment to this contract.

5. ASSIGNMENT OF CLAIMS. (a) Pursuant to the provisions of the Assignment of Claims Act of 1940, as amended (31 U.S. Code 203, 41 U.S. Code 15), if this contract provides for payments aggregating $1,000 or more, claims for monies due or to become due the Contractor from the Government under this contract may be assigned to a bank, trust company, or other financing institution, including any Federal lending agency, and may thereafter be further assigned and reassigned to any such institution. Any

such assignment or reassignment shall cover all amounts payable under this contract and not already paid, and shall not be made to more than one party, except that any such assignment or reassignment may be made to one party as agent or trustee for two or more parties participating in such financing. Notwithstanding any other provision of this contract payments to an assignee of any monies due or to become due under this contract shall not, to the extent provided in said Act, as amended, be subject to reduction or set-off.

(b) In no event shall copies of this contract or of any plans, specifications, or other similar documents relating to work under this contract, if marked "Top Secret," "Secret," "Confidential," or "Restricted," be furnished to any assignee of any claim arising under this contract or to any other person not entitled to receive the same; provided that a copy of any part or all of this contract so marked may be furnished, or any information contained therein may be disclosed, to such assignee upon the prior written authorization of the Contracting Officer.

6. DELAY IN PERFORMANCE. The Contractor shall not be liable for, nor shall performance of work under this contract be terminated for default by reason of, any delay in performance of or failure to perform this contract, if such delay or failure arises out of causes beyond the control and without the fault or negligence of the Contractor. Such causes include, but are not restricted to, acts of God, or of the public enemy, acts of the Government, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, unusually severe weather, and defaults of subcontractors due to any of such causes unless the Contracting Officer shall determine that the supplies or services to be furnished by the subcontractor were obtainable from other sources in sufficient time to permit the Contractor to meet the required delivery schedule.

7. DISPUTES. Except as otherwise provided in this contract, any dispute concerning a question of fact arising under this contract which is not disposed of by agreement shall be decided by the Contracting Officer, who shall reduce his decision to writing and mail or otherwise furnish a copy thereof to the Contractor. Within 30 days from the date of receipt of such copy, the Contractor may appeal by mailing or otherwise furnishing to the Contracting Officer a written appeal addressed to the Secretary, and the decision of the Secretary or his duly authorized representative for the hearing of such appeals shall, unless determined by a court of competent jurisdiction to have been fraudulent, arbitrary, capricious, or so grossly erroneous as necessarily to imply bad faith, be final and conclusive; provided that, if no such appeal is taken, the decision of the Contracting Officer shall be final and conclusive. In connection with any appeal proceeding under this clause, the Contractor shall be afforded an opportunity to be heard and to offer evidence in support of its appeal. Pending final decision of a dispute hereunder, the Contractor shall proceed diligently with the performance of the contract and in accordance with the Contracting Officer's decision.

8. NOTICE AND ASSISTANCE REGARDING PATENT INFRINGEMENT.

(a) The Contractor agrees to report to the Contracting Officer promptly and in reasonable written detail, each claim of patent infringement based on the performance of this contract and asserted against it, or against any of its subcontractors if it has notice thereof.

(b) In the event of litigation against the Government on account of any claim of infringement arising out of the performance of this contract or out of the use of any supplies furnished or construction work performed hereunder, the Contractor agrees that it will furnish to the Government, upon request, all evidence and information in its possession pertaining to the defense of such litigation. Such information shall be furnished at the expense of the Government except in those cases in which the Contractor has agreed to indemnify the Government against the claim being asserted.

9. CONVICT LABOR. In connection with performance of work under this contract, the Contractor agrees not to employ any person undergoing sentence of imprisonment at hard labor.

10. EIGHT-HOUR LAW OF 1912. This contract, to the extent that it is of a character specified in the Eight-Hour Law of 1912 as amended (40 U.S. Code 324-326) and is not covered by the Walsh-Healy Public Contracts Act (41 U.S. Code 35-45), is subject to the following provisions and exceptions of said Eight-Hour Law of 1912 as amended, and to all other provisions and exceptions of said Law:

> No laborer or mechanic doing any part of the work contemplated by this contract, in the employ of the Contractor or any subcontractor contracting for any part of the said work, shall be required or permitted to work more than eight hours in any one calendar day upon such work, except upon the condition that compensation is paid to such laborer or mechanic in accordance with the provisions of this clause. The wages of every such laborer and mechanic employed by the Contractor or any subcontractor engaged in the performance of this contract shall be computed on a basic day rate of eight hours per day; and work in excess of eight hours per day is permitted only upon the condition that every such laborer and mechanic shall be compensated for all hours worked in excess of eight hours per day at not less than one and one-half times the basic rate of pay. For each violation of the requirements of this clause a penalty of five dollars shall be imposed upon the Contractor for each such laborer or mechanic for every calendar day in which such employee is required or permitted to labor more than eight hours upon said work without receiving compensation computed in accordance with this clause; and all penalties thus imposed shall be withheld for the use and benefit of the Government.

11. NONDISCRIMINATION IN EMPLOYMENT. In connection with the performance of work under this contract, the Contractor agrees not to discriminate against any employee or applicant for employment because of race, creed, color, or national origin; and further agrees to insert the foregoing provision in all subcontracts hereunder except subcontracts for standard commercial supplies or for raw materials.

12. OFFICIALS NOT TO BENEFIT. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

13. COVENANT AGAINST CONTINGENT FEES. The Contractor warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the Contractor for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to deduct from the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fees.

14. TERMINATION. (a) The performance of work under the contract may be terminated by the Government in accordance with this clause in whole, or from time to time in part, (1) whenever the Contractor shall default in performance of this contract in accordance with its terms (including in the term "default" any such failure by the Contractor to make progress in the prosecution of the work hereunder as endangers such performance), and shall fail to cure such default within a period of ten days (or such longer period as the Contracting Officer may allow) after receipt from the Contracting Officer of a notice specifying the default, or (2) whenever for any reason the Contracting Officer shall determine that such termination is in the best interests of the Government. Any such termination shall be effected by delivery to the Contractor of a Notice of Termination specifying whether termination is for the default of the Contractor or for the convenience of the Government, the extent to which performance of work under the contract is terminated, and the date upon which such termination becomes effective. If, after notice of termination of this contract for default under (1) above, it is determined that the Contractor's failure to perform or to make progress in performance is due to causes beyond the control and without the fault or negligence of the Contractor pursuant to the provisions of the clause of this contract relating to excusable delays, the Notice of Termination shall be deemed to have been issued under (2) above, and the rights and obligations of the parties hereto shall in such event be governed accordingly.

(b) After receipt of a Notice of Termination and except as otherwise directed by the Contracting Officer, the Contractor shall (1) stop work under the contract on the date and to the extent specified in the Notice of Termination; (2) place no further orders or subcontracts for materials, services, or facilities except as may be necessary for completion of such portion of the work under the contract as is not terminated; (3) terminate all orders and subcontracts to the extent that they relate to the performance of work terminated by the Notice of Termination; (4) assign to the Government, in the manner and to the extent directed by the Contracting Officer, all of the right, title, and interest of the Contractor under the orders or subcontracts so terminated; (5) with the approval or ratification of the Contracting Officer, to the extent he may require, which approval or ratification shall be final and conclusive for all purposes of this clause, settle all outstanding liabilities and all claims arising out of such termination of orders and subcontracts, the cost of which would be reimbursable, in whole or in part, in accordance with the provisions of this contract; (6) transfer title (to the extent that title has not already been transferred) and, in the manner, to the extent, and at the times

, in which case the Government shall have the right, in its discretion, to settle or pay any or all claims arising out of the termination of such orders and subcontracts.

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directed by the Contracting Officer, deliver to the Government (i) the fabricated or unfabricated parts, work in process, completed work, supplies, and other material produced as a part of, or acquired in respect of the performance of, the work terminated by the Notice of Termination, (ii) the completed or partially completed plans, drawings, information, and other property which, if the contract had been completed, would be required to be furnished to the Government, and (iii) the jigs, dies, and fixtures, and other special tools and tooling acquired or manufactured for the performance of this contract for the cost of which the Contractor has been or will be reimbursed under this contract; (7) use its best efforts to sell in the manner, at the times, to the extent, and at the price or prices directed or authorized by the Contracting Officer, any property of the types referred to in provision (6) of this paragraph, provided, however, that the Contractor (i) shall not be required to extend credit to any purchaser, and (ii) may acquire any such property under the conditions prescribed by and at a price or prices approved by the Contracting Officer; and provided further that the proceeds of any such transfer or disposition shall be applied in reduction of any payments to be made by the Government to the Contractor under this contract or shall otherwise be credited to the price or cost of the work covered by this contract or paid in such other manner as the Contracting Officer may direct; (8) complete performance of such part of the work as shall not have been terminated by the Notice of Termination; and (9) take such action as may be necessary, or as the Contracting Officer may direct; for the protection and preservation of the property related to this contract which is in the possession of the Contractor and in which the Government has or may acquire an interest. The Contractor shall proceed immediately with the performance of the above obligations notwithstanding any delay in determining or adjusting the amount of the fixed fee, or any item of reimbursable cost, under this clause. At any time after expiration of the plant clearance period, as defined in Section VIII, Armed Services Procurement Regulation, as it may be amended from time to time, the Contractor may submit to the Contracting Officer a list, certified as to quantity and quality, of any or all items of termination inventory not previously disposed of, exclusive of items the disposition of which has been directed or authorized by the Contracting Officer, and may request the Government to remove such items or enter into a storage agreement covering them. Not later than fifteen (15) days thereafter, the Government will accept title to such items and remove them or enter into a storage agreement covering the same, provided that the list submitted shall be subject to verification by the Contracting Officer upon removal of the items, or if the items are stored, within forty-five (45) days from the date of submission of the list, and any necessary adjustment to correct the list as submitted shall be made prior to final settlement.

(c) After receipt of a Notice of Termination, the Contractor shall submit to the Contracting Officer its termination claim in the form and with the certification prescribed by the Contracting Officer. Such claim shall be submitted promptly but in no event later than two years from the effective date of termination, unless one or more extensions in writing are granted by the Contracting Officer upon request of the Contractor made in writing within such two-year period or authorized extension thereof. However, if the Contracting Officer determines that the facts justify such action, he may receive and act upon any such termination claim at any time after such two-year period or any extension thereof. Upon failure of the Contractor to submit its termination claim within the time allowed, the Contracting Officer may determine, on the basis of information available to him, the amount, if any, due to the Contractor by reason of the termination and shall thereupon pay to the Contractor the amount so determined.

(d) Subject to the provisions of paragraph (c), the Contractor and the Contracting Officer may agree upon the whole or any part of the amount or amounts to be paid (including an allowance for the fixed fee) to the Contractor by reason of the total or partial termination of work pursuant to this clause. The Contract shall be amended accordingly, and the Contractor shall be paid the agreed amount.

(e) In the event of the failure of the Contractor and the Contracting Officer to agree in whole or in part, as provided in paragraph (d) above, as to the amounts with respect to costs and fixed fee, or as to the amount of the fixed fee, to be paid to the Contractor in connection with the termination of work pursuant to this clause, the Contracting Officer shall determine, on the basis of information available to him, the amount, if any, due to the Contractor by reason of the termination and shall pay to the Contractor the amount determined as follows:

(1) If the settlement includes cost and fixed fee

(i) There shall be included therein all costs and expenses reimbursable in accordance with this contract, not previously paid to the Contractor for the performance of this contract prior to the effective date of the Notice of Termination, and such of these costs as may continue for a reasonable time thereafter with the approval of or as directed by the Contracting Officer, provided, however, that the Contractor shall proceed as rapidly as practicable to discontinue such costs.

(ii) There shall be included therein so far as not included under (i) above, the cost of settling and paying claims arising out of the termination of work under subcontracts or orders, as provided in paragraph (b) (5) above, which are properly chargeable to the terminated portion of the contract.

(iii) There shall be included therein the reasonable costs of settlement, including accounting, legal, clerical, and other expenses reasonably necessary for the preparation of settlement claims and supporting data with respect to the terminated portion of the contract and for the termination and settlement of subcontracts thereunder, together with reasonable storage, transportation, and other costs incurred in connection with the protection or disposition of termination inventory; provided, however, that if the termination is for default of the Contractor there shall not be included any amounts for the preparation of the Contractor's settlement proposal.

(iv) There shall be included therein a portion of the fixed fee payable under the contract determined as follows:

(A) In the event of the termination of this contract for the convenience of the Government and not for the default of the Contractor, there shall be paid a percentage of the fee equivalent to the percentage of the completion of work contemplated by the contract, less fixed fee payments previously made hereunder.

(B) In the event of the termination of this contract for the default of the Contractor, the total fixed fee payable shall be such proportionate part of the fee (or, if this contract calls for services and/or articles of different types, of such part of the fee as is reasonably allocable to the type of service and/or article under consideration) as the total number of services and/or articles delivered to and accepted by the Government bears to the total number of services and/or articles of a like kind called for by this contract.

If the amount determined under this subparagraph is less than the total payment of the fixed fee theretofore made to the Contractor, the Contractor shall repay to the Government the excess amount.

(2) If the settlement includes only the fixed fee, the amount thereof will be determined in accordance with subparagraph (e)(1)(iv) above.

(f) The Contractor shall have the right of appeal, under the clause of this contract entitled "Disputes," from any determination made by the Contracting Officer under paragraphs (c) or (e) above, except that if the Contractor has failed to submit its claim within the time provided in paragraph (c) above and has failed to request extension of such time, he shall have no such right of appeal. In any case where the Contracting Officer has made a determination of the amount due under paragraph (c) or (e) above, the Government shall pay to the Contractor the following: (i) if there is no right of appeal hereunder or if no timely appeal has been taken, the amount so determined by the Contracting Officer, or (ii) if an appeal has been taken, the amount finally determined on such appeal.

(g) In arriving at the amount due the Contractor under this clause there shall be deducted (1) all unliquidated advance or other unliquidated payments theretofore made to the Contractor, (2) any claim which the Government may have against the Contractor in connection with this contract, and (3) the agreed price for, or the proceeds of sale of, any materials, supplies, or other things acquired by the Contractor or sold pursuant to the provisions of this clause and not otherwise recovered by or credited to the Government.

(h) In the event of a partial termination, the portion of the fixed fee which is payable with respect to the work under the continued portion of the contract shall be equitably adjusted by agreement between the Contractor and the Contracting Officer, and such adjustment shall be evidenced by an amendment to this contract.

(i) The Government may from time to time, under such terms and conditions as it may prescribe, make partial payments and payments on account against costs incurred by the Contractor in connection with the terminated portion of the contract whenever in the opinion of the Contracting Officer the aggregate of such payments shall be within the amount to which the Contractor will be entitled hereunder. If the total of such payments is in excess of the amount finally determined to be due under this clause, such excess shall be payable by the Contractor to the Government upon demand, together with interest computed at the rate of six per cent (6%) per annum, for the period from the date such excess payment is received by the Contractor to the date on which such excess is repaid to the Government; provided, however, that no interest shall be charged with respect to any such excess payment attributable to a reduction in the Contractor's claim by reason of retention or other disposition of termination inventory until ten (10) days after the date of such retention or disposition.

(j) The provisions of this clause relating to the fixed fee shall be inapplicable if this contract does not provide for payment of a fixed fee.

(k) Unless otherwise provided for in this contract, or by applicable statute, the Contractor from the effective date of termination and for a period of six (6) years after final settlement under this contract, shall preserve and make available to the Government at all reasonable times at the office of the Contractor, but without direct charge to the Government, all its books, records, documents, and other evidence bearing on the cost and expenses of the Contractor under this contract and relating to the work terminated hereunder, or, to the extent approved by the Contracting Officer, photographs, micro-photographs, or other authentic reproductions thereof.

15. NOTICE TO THE GOVERNMENT OF LABOR DISPUTES. (a) Whenever the Contractor has knowledge that any actual or potential labor dispute is delaying or threatens to delay the timely performance of this contract, the Contractor shall immediately give notice thereof, including all relevant information with respect thereto, to the Contracting Officer.

16. REPORTING OF ROYALTIES. If this contract is in an amount which exceeds $10,000 the Contractor agrees to report in writing to the Contracting Officer during the performance of this contract and prior to its completion or final settlement the amount of any royalties or royalty rates paid or to be paid by it directly to others in connection with the performance of this contract, together with the names and addresses of licensors to whom such payments are made and either the patent numbers involved or such other information as will permit identification of the patents or other basis on which royalties are to be paid. Where the Contractor's compliance with the foregoing

reporting requirement is found by the Contracting Officer to be impracticable because of the size of the Contractor's business or because of the nature of its accounting procedures, the Contractor may furnish one or more reports based on its established accounting periods and covering the entire contract period, of royalties in excess of $1,000 (if computed on an annual basis) paid or to be paid to each licensor on the Contractor's overall business, together with such other information as will permit identification of the patents or other basis on which royalties are to be paid, in which event the Contractor shall furnish to the Contracting Officer, upon his request and at Government expense, an allocation of such royalty payments to Government business or to the work or supplies covered by this contract; reference to any such periodic royalty reports, previously furnished to any Government agency and covering the period of performance of this contract, shall constitute compliance with the reporting requirement of this clause. If this contract is in an amount which exceeds $10,000 and no royalties or royalty rates are paid or to be paid directly to others under the circumstances set forth above, the Contractor agrees so to report in writing to the Contracting Officer prior to completion or final settlement of this contract.

17. SUBCONTRACTS. (a) The Contractor shall give advance notification to the Contracting Officer of any proposed subcontract or purchase order hereunder which is either (i) on a cost or cost-plus-a-fixed-fee basis, or (ii) on a fixed price basis exceeding in dollar amount either $25,000 or five per centum of the total estimated cost of this contract.

(b) No contract shall be made by the Contractor with any other party for furnishing articles or services to be paid for on a time and material or labor-hour basis without the written approval of the Contracting Officer.

(c) No contract shall be made by the Contractor for furnishing any of the completed or substantially completed articles, spare parts, or work herein contracted for without the written approval of the Contracting Officer. The Contracting Officer may approve the Contractor's purchasing system and from time to time rescind and reinstate such approval. While such approval is in effect, the requirement of approval of the contracts referred to in the first sentence of this paragraph (c) shall be considered waived, but such waiver shall not extend to nor dispense with the requirements for approval of the party with whom such contract is to be placed.

(d) It is the policy of the Government as declared by the Congress to bring about the greatest utilization of small business concerns which is consistent with efficient production.

(e) The Contractor agrees to accomplish the maximum amount of subcontracting to small business concerns that the Contractor finds to be consistent with the efficient performance of this contract.

(f) The cost-plus-a-percentage-of-cost system of contracting shall not be used by the Contractor.

18. REPRODUCTION RIGHTS. It is understood and agreed that the Contractor does not convey to the Government any reproduction rights in or to the supplies called for herein by virtue of the terms of this contract, except as may be herein otherwise provided.

19. EMPLOYMENT OF ALIENS. (a) If this contract calls for the furnishing or constructing of aircraft, aircraft parts, or aeronautical accessories, no aliens employed by the Contractor shall be permitted to have access to the plans or specifications or the work under construction, or to participate in the contract trials, without the written consent beforehand, of the Secretary of his duly authorized representative.

(b) For all work under the contract other than the furnishing or constructing of aircraft, aircraft parts, or aeronautical accessories, the foregoing requirements of Section (j) of the Act of July 2, 1926 (10 U.S. Code 310) (j) will not apply, but the employment of persons will be subject to the military security requirements of this contract.

20. GOVERNMENT PROPERTY. (a) The Government shall deliver to the Contractor the property described in the Schedule or the Specifications at the times stated therein, or if not so stated in sufficient time to enable the Contractor to perform this contract. If any of such property is not delivered to the Contractor by such time or times, the Contracting Officer upon written request of the Contractor shall equitably adjust the time of performance of this contract. In no event shall the Government be liable to the Contractor for damages or loss of profit by reason of any delay in or failure to deliver any or all of the items set forth in the Schedule or Specifications.

(b) Title to all property furnished by the Government shall remain in the Government. Title to all property purchased by the Contractor, for the cost of which the Contractor is entitled to be reimbursed as a direct item of cost under this contract, shall pass to and vest in the Government upon delivery of such property by the vendor. Title to other property, the cost of which is reimbursable to the Contractor under this contract, shall pass to and vest in the Government upon (i) issuance for use of such property in the performance of this contract, or (ii) commencement of processing or use of such property in the performance of this contract or (iii) reimbursement of the cost thereof by the Government, which ever first occurs. All of the items to be furnished by the Government, as set forth in the Schedule or Specifications, together with all property acquired by the Contractor title to which vests in the Government under this paragraph, are subject to the provisions of this clause and are hereinafter collectively referred to as "Government Property."

(c) Title to the Government Property shall not be affected by the incorporation or attachment thereof to any property not owned by the Government, nor shall such Government Property, or any part thereof, be or become a fixture or lose its identity as personalty by reason of affixation to any realty. The Contractor shall maintain adequate property control records of the Government Property and shall identify the Government Property as such in accordance with the provisions of the "Manual for Control of Government Property in Possession of Contractors" dated March 1951, which is incorporated herein by reference.

(d) The Government Property provided or furnished pursuant to the terms of this contract shall, unless otherwise provided herein, be used only for the performance of this contract.

(e) The Contractor shall maintain and administer in accordance with sound industrial practice, a program for the maintenance, repair, protection and preservation of Government Property so as to assure its full availability and usefulness for the performance of this contract. The Contractor shall take all reasonable steps to comply with all appropriate directions or instructions which the Contracting Officer may prescribe as reasonably necessary for the protection of Government Property.

(f)(i) The Contractor shall not be liable for any loss of or damage to the Government Property, or for expenses incidental to such loss of or damage, except that the Contractor shall be responsible for any such loss or damage (including expenses incidental thereto)(A) which results from willful misconduct or lack of good faith on the part of -

any of the Contractor's directors or officers, or on the part of any of its managers, superintendents, or other equivalent representatives, who has supervision or direction of (I) all or substantially all of the Contractor's business, or (II) all or substantially all of the Contractor's operations at any one plant or separate location in which this contract is being performed, or (III) a separate and complete major industrial operation in connection with the performance of this contract; or (B) which results from a failure on the part of the Contractor, due to the wilful misconduct or lack of good faith on the part of any of its directors, officers, or other representatives mentioned in subparagraph (A) above, to maintain and administer, in accordance with sound industrial practice, the program for maintenance, repair, protection and preservation of Government Property as required by paragraph (e) hereof, or which results from a failure on the part of the Contractor to take all reasonable steps to comply with any appropriate written directions of the Contracting Officer under paragraph (e) hereof; or (C) for which the Contractor is otherwise responsible under the express terms of this contract or (D) which results from a risk expressly required to be insured under this contract, but only to the extent of the insurance so required to be procured and maintained, or to the extent of insurance actually procured and maintained, whichever is greater; or (E) which results from a risk which is in fact covered by insurance or for which the Contractor is otherwise reimbursed, but only to the extent of such insurance or reimbursement; provided that, if more than one of the above exceptions shall be applicable in any case, the Contractor's liability under any one exception shall not be limited by any other exception.

(ii) The Contractor shall not be reimbursed for, and shall not include as an item of overhead, the cost of insurance, or any provision for a reserve, covering the risk of loss of or damage to the Government Property, except to the extent that the Government may have required the Contractor to carry such insurance under any other provision of this contract.

(iii) Upon the happening of loss or destruction of or damage to the Government Property, the Contractor shall notify the Contracting Officer thereof, and shall communicate with the Loss and Salvage Organization, if any, now or hereafter designated by the Contracting Officer, and with the assistance of the Loss and Salvage Organization so designated (unless the Contracting Officer has designated that no such organization be employed), shall take all reasonable steps to protect the Government Property from further damage, separate the damaged and undamaged Government property, put all the Government Property in the best possible order, and furnish to the Contracting Officer a statement of (A) the lost, destroyed and damaged Government Property, (B) the time and origin of the loss, destruction or damage, (C) all known interests in commingled property of which the Government Property is a part, and (D) the insurance, if any, covering any part of or interest in such commingled property. The Contractor shall make repairs and renovations of the damaged Government Property or take such other action, as the Contracting Officer directs.

(iv) In the event the Contractor is indemnified, reimbursed, or otherwise compensated for any loss or destruction of or damage to the Government property, it shall use the proceeds to repair, renovate or replace the Government Property involved, or shall credit such proceeds against the cost of the work covered by the contract, or shall otherwise reimburse the Government as directed by the Contracting Officer. The Contractor shall do nothing to prejudice the Government's right to recover against third parties for any such loss, destruction or damage and, upon the request of the Contracting Officer, shall, at the Government's expense, furnish to the Government all reasonable assistance and cooperation (including the prosecution of suit and the execution of instruments of assignment in favor of the Government) in obtaining recovery.

(v) In the event any aircraft are to be furnished under this contract, any loss or destruction of, or damage to, such aircraft or other Government Property occurring in connection with operations of said aircraft will be governed by the clause of this

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contract captioned "Flight Risks," to the extent such clause is, by its terms, applicable.

(g) The Government shall at all reasonable times have access to the premises where any of the Government Property is located.

(h) The Government Property shall remain in the possession of the Contractor for such period of time as is required for the performance of this contract unless the Contracting Officer determines that the interests of the Government require removal of such property. In such case the Contractor shall promptly take such action as the Contracting Officer may direct with respect to the removal and shipping of Government Property. In any such instance, the contract may be amended to accomplish an equitable adjustment in the terms and provisions thereof.

(i) Upon the completion of this contract, or at such earlier date as may be fixed by the Contracting Officer, the Contractor shall submit to the Contracting Officer in a form acceptable to him, inventory schedules covering all items of the Government Property not consumed in the performance of this contract (including any resulting scrap), or not theretofore delivered to the Government, and shall deliver or make such other disposal of the Government Property as may be directed by the Contracting Officer. Recoverable scrap shall be reported in accordance with a procedure and in such form as the Contracting Officer may direct. The net proceeds of any such disposal approved by the Contracting Officer shall be credited to the cost of the work covered by the contract or shall be paid in such manner as the Contracting Officer may direct.

(j) Unless otherwise provided herein, the Government shall not be under any duty or obligation to restore or rehabilitate, or to pay the costs of the restoration or rehabilitation of the Contractor's plant or any portion thereof which is affected by the removal of any Government Property.

(k) Directions of the Contracting Officer and communications of the Contractor issued pursuant to this clause shall be in writing.

21. ADDITIONAL PROVISIONS CONCERNING GOVERNMENT PROPERTY. (a) Government's Option. The Contracting Officer may at his option from time to time furnish the Contractor with materials and/or supplies* not readily obtainable in the open market and which are required by the Contractor for the performance of this contract. In such event an equitable adjustment of the estimated cost and of the amount of the fixed fee to be paid to the Contractor shall be made as provided in the clause of this contract entitled "Changes."

(b) Delivery and Disposition. In the event materials, supplies, equipment or other property are furnished by the Government to the Contractor under this contract, except such materials and/or supplies furnished under the terms of paragraph (a) hereof, for installation in the products and materials or other items called for hereunder, or for use in connection with the performance of this contract, said Government property shall be delivered to the Contractor f.o.b. cars or carrier's equipment at the plant or plants of Contractor, or the point or points nearest thereto that rail carrier service is available, and any of such materials, supplies, equipment or other property not permanently installed in the products and materials or other items called for hereunder, or properly expended by the Contractor in the performance of this contract, shall unless otherwise provided herein, be delivered by the Contractor to the Government f.o.b. cars or carrier's equipment at Contractor's plant or at the point or points nearest thereto at which the shipment can be delivered into carrier's possession, packed for domestic shipment. All said shipments shall be made on Government bills of lading, but the Contractor shall make application therefor on Air Materiel Command Form No. 63A, which application shall be made in the manner prescribed in the Schedule. In inserting descriptions in Government bills of lading, the Contractor will comply with the rules and provisions of the freight classifications and tariffs of the carrier or carriers involved.

* in addition to those contemplated by Technical Exhibit "I".

22. GUARANTY. (a) The Contractor guarantees that all work called for herein shall meet and comply with the pertinent specifications, including performance of any and all articles called for under the terms hereof, that the work shall be executed in the best and most workmanlike manner, by qualified, careful and efficient workers, and that the materials shall be of the best quality of their respective kinds unless otherwise authorized by the Contracting Officer.

(b) At the election of the Government, work called for hereunder which does not conform to the requirements of this contract may be accepted notwithstanding such failure to conform to this contract or to the specifications and guarantees, but in such event an appropriate reduction may be made in the fee. If any dispute shall arise concerning a proposed reduction in the fee the same shall be regarded as a dispute concerning a question of fact within the meaning of the clause of this contract entitled "Disputes".

23. INSURANCE. (a) Notwithstanding the provisions of Part 2 of Section XV of the Armed Services Procurement Regulations, the Government's obligation to reimburse the Contractor for the cost of bonds, insurance and any pension or retirement plan, incurred in connection with performance of the contract, shall be limited to the cost of such bonds, insurance, pension or retirement plan as approved by the Contracting Officer. In addition to the allowance of such costs, the Contractor shall also be allowed costs and expenses incurred in the defense and/or discharge of such claims of others on account of death or bodily injury of persons or loss or destruction of or damage to property as may arise out of or in connection with the performance of the work under this contract; provided, that such reimbursement shall not include any amount for which the Contractor is indemnified or compensated by insurance or otherwise, or any amount for which it would have been so indemnified or compensated except for the failure of the Contractor to procure or maintain bonds or insurance in accordance with the requirement of the Contracting Officer. The foregoing shall not restrict the right of the Contractor to be reimbursed for the reasonable cost of necessary insurance covering the Contractor's property or property for which the Contractor is responsible to someone other than the Government and which is used or to be used in the performance of this contract.

(b) In addition to the Contractor's regular insurance program which may be approved pursuant to paragraph (a) hereof the Contractor agrees to procure and thereafter maintain such additional bonds, insurance, pension or retirement plans, in such forms and in such amounts and for such periods of time as the Contracting Officer may require in writing and the Contractor shall be reimbursed for the cost thereof.

(c) The Contractor shall give the Contracting Officer or his representative immediate notice in writing of any suit or action filed against the Contractor arising out of the performance of this contract and of any claim against the Contractor, the cost and expense of which are reimbursable under the provisions of paragraph (a) hereof and the risk of which is then uninsured or in which the amount claimed exceeds the amount of insurance coverage. The Contractor shall furnish immediately to the Contracting Officer copies of pertinent papers received by the Contractor. Insofar as the following shall not conflict with any policy or contract of insurance and, upon request of the Contracting Officer, the Contractor shall do any and all things to effect an assignment and subrogation in favor of the Government of all Contractor's rights and claims, except against the Government, arising from or growing out of such asserted claims, and if required by the Contracting Officer, shall authorize representatives of the Government to settle and/or defend any such claim and to represent or take charge of any such litigation affecting the Contractor.

24. RELEASE PROVISIONS. (a) Prior to final payment and as a condition thereof, the Contractor shall furnish the Government with a release of all claims against the

Government arising under and by virtue of this contract, other than (i) such claims, if any, as may be specifically excepted by the Contractor from the operation of the release in stated amounts to be set forth therein, or in estimated amounts where the amounts are not susceptible of exact statement, and (ii) any claim based upon responsibility of the Contractor to third parties arising out of the performance of this contract not known to the Contractor at the time of furnishing the release.

(b) Even though the existence or amount thereof shall not be determined until after the furnishing of such release as is described next above, reimbursement to be made for payments made by the Contractor shall include, along with wages and salaries otherwise reimbursable, all additional amounts determined (either by approval of the Contracting Officer or by litigation as hereinafter provided) to be due and payable for overtime compensation and allowances under local, State or Federal laws in connection with such wages and salaries.

(c) The Contractor shall promptly notify the Contracting Officer of any claims of the type described in paragraph (a)(ii) above which are asserted subsequent to the execution of the release.

(d) In the event the Contracting Officer shall determine that the best interests of the Government required that the Contractor initiate or defend litigation in connection with claims of third parties arising out of the performance of this contract, the Contractor will proceed with such litigation in good faith and the costs and expenses of such litigation, including judgments and court costs, allowances rendered or awarded in connection with suits for wages, overtime or salaries, and reasonable attorneys' fees for private counsel, shall be reimbursable under this contract. The term "litigation" shall include suits at law or in equity and proceedings before any Governmental agency having jurisdiction over the claim.

25. GRATUITIES. A. The Government may, by written notice to the contractor, terminate the right of the contractor to proceed under this contract if it is found after notice and hearing by the Secretary or his duly authorized representative that gratuities in the form of entertainment, gifts or otherwise, were offered or given by the contractor or any agent or representative of the contractor to any officer or employee of the Government with a view toward securing a contract or securing favorable treatment with respect to the awarding or amending or the making of any determination with respect to the performing of such contract; provided that the existence of the facts upon which the Secretary or his duly authorized representative makes such findings shall be in issue and may be reviewed in any competent court.

B. In the event this contract is terminated as provided in paragraph (a) hereof, the Government shall be entitled: (i) to pursue the same remedies against the contractor as it could pursue in the event of a breach of the contract by the Contractor and (ii) as a penalty in addition to any other damages to which it may be entitled by law to exemplary damages in an amount as determined by the Secretary or his duly authorized representative which shall be not less than three (3) or more than ten (10) times the costs incurred by the contractor in providing any such gratuities to any such officer or employee.

C. The rights and remedies of the Government provided in this clause shall not be exclusive and are in addition to any other rights and remedies provided by law or under this contract.

RENEGOTIATION

26. (a) This contract is subject to the Renegotiation Act of 1951 (P.L.9. 82nd Congress) and shall be deemed to contain all the provisions required by Section 104 of said Act.

(b) The contractor (which term as used in this clause means the party contracting to furnish the materials or perform the work required by this contract) agrees to insert the provisions of this clause, including this paragraph (b), in all subcontracts as required by Section 104 of the Renegotiation Act of 1951: provided, that the contractor shall not be required to insert the provisions of this clause in any subcontract of a class or type described in Section 106 (a) of the Renegotiation Act of 1951.

27. MILITARY SECURITY REQUIREMENTS

(a) The provisions of this clause shall apply to the extent that this contract involves access to security information classified "Top Secret", "Secret", "Confidential", or "Restricted".

(b) The Government shall notify the Contractor of the Security Classification of this contract and the elements thereof, and of any subsequent revisions in such security classification, by the use of a Security Requirements Check List (DD Form 254) and Appendage thereto (DD Form 254-1).

(c) To the extent the Government has indicated as of the date of this contract, or thereafter indicates, security classification under this contract as provided in paragraph (b) above, the Contractor shall safeguard all classified elements of this contract and shall provide and maintain a system of security controls within its own organization in accordance with the requirements of (i) the Department of Defense Industrial Security Manual for Safeguarding Classified Security Information as in effect on date of this contract, which Manual is hereby incorporated by reference and made a part of this contract, (ii) any amendments to said Manual required by the demands of national security as determined by the Government and made after the date of this contract, notice of which has been furnished to the Contractor by the Contracting Officer, and (iii) those provisions of written agreements entered into by the parties pertaining to the adaptation of the Manual to the Contractor's business.

(d) Designated representatives of the Government responsible for inspection pertaining to industrial security shall have the right to inspect at reasonable intervals the procedures, methods and facilities utilized by the Contractor in complying with the requirements of the terms and conditions of this clause. Should the Government, through its authorized representative, determine that the Contractor has not complied with such requirements, the Government shall inform the Contractor in writing of the proper actions to be taken in order to effect compliance with such requirements.

(e) If, subsequent to the date of this contract, the security classifications or requirements under this contract are changed by the Government as provided in this clause, and if such change causes an increase or decrease in the estimated cost of performance of this contract, the estimated cost and fixed fee, shall, to the extent appropriate, be subject to an equitable adjustment. Any such equitable adjustment shall be accomplished in the manner set forth in the clause of this contract entitled "Changes."

(g) The Contractor agrees to insert, in all subcontracts hereunder which involve access to classified security information, provisions which shall conform substantially to the language of this clause, including this paragraph (g) but excluding paragraph (f) of this clause. The Contractor may insert in any such subcontract, and any such subcontract entered into thereunder may contain, in lieu of paragraph (f) of this clause, provisions which permit equitable adjustments to be made in the subcontract price or in the estimated cost and fixed fee of the subcontract (as appropriate to the type of subcontract involved) on account of changes in security classifications or requirements made under the provisions of this clause subsequent to the date of the subcontract involved.

(h) The Contractor also agrees that it shall determine that any subcontractor proposed by it for the furnishing of supplies and services which will involve access to classified security information in the Contractor's custody has been granted an appropriate facility security clearance, which is still in effect, prior to being accorded access to such classified security information.

28. RECORDS

(a) (1) The Contractor agrees to maintain books, records, documents, and other evidence pertaining to the costs and expenses of this contract (hereinafter collectively called the "records") to the extent and in such detail as will properly reflect all net costs, direct and indirect, of labor, materials, equipment, supplies and services, and other costs and expenses of whatever nature for which reimbursement is claimed under the provisions of this contract. The Contractor's accounting procedures and practices shall be subject to the approval of the Contracting Officer; provided, however, that no material change will be required to be made in the Contractor's accounting procedures and practices if they conform to generally accepted accounting practices and if the costs properly applicable to this contract are readily ascertainable therefrom.

(2) The Contractor agrees to make available at the office of the Contractor at all reasonable times during the period set forth in subparagraph (4) below any of the records for inspection, audit or reproduction by any authorized representative of the Department or of the Comptroller General.

(3) In the event the Comptroller General or any of his duly authorized representatives determines that his audit of the amounts reimbursed under this contract as transportation charges will be made at a place other than the office of the Contractor, the Contractor agrees to deliver, with the reimbursement voucher covering such charges or as may be otherwise specified within two years after reimbursement of charges covered by any such voucher, to such representative as may be designated for the purpose through the Contracting Officer such documentary evidence in support of transportation costs as may be required by the Comptroller General or any of his duly authorized representatives.

(4) Except for documentary evidence delivered to the Government pursuant to subparagraph (3) above, the Contractor shall preserve and make available its records for a period of six years (unless a longer period of time is provided by applicable statute) from the date of the voucher or invoice submitted by the Contractor after the completion of the work under the contract and designated by the Contractor as the "completion voucher" or "completion invoice" or, in the event this contract has been completely terminated, from the date of the termination settlement agreement; provided however, that records which relate to (A) appeals under the clause of this contract entitled "Disputes", (B) litigation or the settlement of claims arising out of the performance of this contract, or (C) costs or expenses of the contract as to which exception has been taken by the Comptroller General or any of his duly authorized representatives shall be retained by the Contractor until such appeals, litigation, claims, or exceptions have been disposed of, but in no event for less than the six-year period mentioned above.

(5) Except for documentary evidence delivered pursuant to subparagraph (3) above, and the records described in the proviso of subparagraph (4) above, the Contractor may in fulfillment of its obligation to retain its records as required by this clause substitute photographs, microphotographs or other authentic reproductions of such records, after the

expiration of two years following the last day of the month of reimbursement to the Contractor of the invoice or voucher to which such records relate, unless a shorter period is authorized by the Contracting Officer with the concurrence of the Comptroller General or his duly authorized representative.

(6) The provisions of this paragraph (a), including this subparagraph (6), shall be applicable to and included in each subcontract hereunder which is on a cost, cost-plus-a-fixed-fee, time-and-material, or labor-hour basis.

(b) The Contractor further agrees to include in each of his subcontracts hereunder, other than those set forth in subparagraph (a) (6) above, a provision to the effect that the subcontractor agrees that the Comptroller General or the Department, or any of their duly authorized representatives, shall, until the expiration of three years after final payment under the subcontract have access to and the right to examine any directly pertinent books, documents, papers, and records of such subcontractor involving transactions related to the subcontract. The term "subcontract", as used in this paragraph (b) only, excludes (i) purchase orders not exceeding $1,000. and (ii) subcontracts or purchase orders for public utility services at rates established for uniform applicability to the general public.

29. BUY AMERICAN ACT

The Contractor agrees that there will be delivered under this contract only such unmanufactured articles, materials and supplies (which term "articles, materials and supplies" is hereinafter referred to in this clause as "supplies") as have been mined or produced in the United States, and only such manufactured supplies as have been manufactured in the United States substantially all from supplies mined, produced, or manufactured, as the case may be, in the United States. Pursuant to the Buy American Act (41 U. S. Code 10 a-d), the foregoing provision shall not apply (i) with respect to supplies excepted by the Secretary from the application of that Act, (ii) with respect to supplies for use outside the United States, (iii) with respect to the supplies to be delivered under this contract which are of a class or kind determined by the Secretary or his duly authorized representative not to be mined, produced, or manufactured, as the case may be, in the United States in sufficient and reasonably available commercial quantities and of a satisfactory quality, or (iv) with respect to such supplies, from which the supplies to be delivered under this contract are manufactured, as are of a class or kind determined by the Secretary or his duly authorized representative not to be mined, produced, or manufactured, as the case may be, in the United States in sufficient and reasonably available commercial quantities and of a satisfactory quality, provided that this exception (iv) shall not permit delivery of supplies manufactured outside the United States if such supplies are manufactured in the United States in sufficient and reasonably available commercial quantities and of a satisfactory quality.

30. ---PATENT RIGHTS. (a) The Contractor agrees to obtain from each of its employees engaged in the performance of the work called for under this contract, and will require as a condition of continued employment on said work, an agreement by the terms of which each of said employees agrees: (i) to make written disclosure promptly to the Contracting Officer of all inventions of the employee which are conceived or first reduced to practice, or both conceived and reduced to practice, during the term of his employment; (ii) that rights in inventions made by the employee during the term of his employment shall be determined in accordance with the provisions of Executive Order 10096 of 23 January 1950 providing for a uniform patent policy for the Government with respect to inventions made by Government employees and for the administration of such policy; (iii) to sign and execute all papers necessary to the filing and prosecution of applications for patents on such inventions and for conveying to the Government the rights to which it is entitled in accordance with the determination made under the provisions of Executive Order 10096; (iv) that he has not entered into, and will not enter into, any arrangement or agreement to evade the intent of the agreement required hereby, namely, that the Government shall obtain without further payment such rights in and to all inventions made by the employee during the term of his employment as the Government may require under the provisions of Executive Order 10096; and (v) for himself, his heirs and assigns, to assert no copyright at common law and to make no claim to copyright by statute in any copyrightable material first produced by him as a function of the assigned duties of his employment. In any case where the Contractor is unable to obtain an agreement as aforesaid and employment of such employee is considered in the interest of the Government, the Contractor shall report such matters to the Contracting Officer and shall cooperate with the Government in the negotiation with such employee of a mutually acceptable agreement.

(b) The Contractor obligates itself to use its best efforts to secure full compliance by employees with the provisions of agreements obtained under paragraph (a) of this clause, not only while employed but also after employment has ended. If litigation to obtain such compliance should become necessary, Contractor agrees either to (1) initiate and pursue such litigation if, and to the extent, requested by the Government and the expense thereof shall be borne by the Government, or (2) assign to the Government all rights acquired by the Contractor for the benefit of the Government to enforce the provisions of such agreements of employment. The election as to which course of action is to be pursued in accordance with (1) or (2) above shall reside in the Contracting Officer. If, to the best of the Contractor's knowledge and belief, no inventions have been conceived or first actually reduced to practice under this contract, the Contractor shall so certify to the Contracting Officer.

(c) The Contractor agrees that the Government shall have the unlimited right to duplicate, use and disclose, for any governmental purpose whatsoever (including the right to give to foreign governments for their use as the national interest of the United States may require) of engineering and scientific reports, drawings, blueprints, technical data, bills of material, photographs, models or the like produced in the performance of the contract or with substantial government aid.

(d) The Contractor agrees to exert all reasonable effort to negotiate for inclusion (i) in the subcontract for operation and maintenance of the Technical Systems Laboratory, Patrick Air Force Base, provided for in this contract, of this Patent Rights Clause, and (ii) in any other subcontract hereunder of a $1,000 or more, in which payment is to be made for experimental, developmental, or research work, of a Patent Rights Clause as set forth in ASPR 9-107.1 or one approved by the Contracting Officer. In the event of refusal by the subcontractor in (i) above, to accept such Patent Rights Clause, the Contractor shall cooperate with the Government in the negotiation with such subcontractor of a mutually acceptable Patent Rights Clause. In the event of refusal by any subcontractor in (ii) above, to accept the Clause in ASPR 9-107.1, or one approved by the Contracting Officer, the Contractor shall obtain the written authorization of the Contracting Officer, (which authorization may be granted with respect to a particular subcontract) to proceed with the subcontract, and shall cooperate with the Government in the negotiation with such subcontractor of a mutually acceptable Patent Rights Clause: provided, however, that the Contractor shall in any event require the subcontractor to grant to the Government, Patent Rights under subject inventions (defined in ASPR 9-107.1) of no less scope and no less favorable terms than those which the Contractor has under such subcontracts, except that in no event shall the subcontractor be required to grant to the Government, Patent Rights in excess of those herein agreed to be granted to the Government by the Contractor.

(e) The Contractor agrees to notify the Contracting Officer in writing of any subcontract containing a Patent Rights Clause, to furnish to the Contracting Officer a copy of such clause, and promptly to notify the Contracting Officer when such subcontract is completed. It is understood that with respect to such subcontract clause, the Government is a third party beneficiary; and the Contractor hereby assigns to the Government all the rights that the Contractor would have to enforce the obligations of the subcontractor with respect to subject Inventions. The Contractor shall not be obligated to enforce the agreements of any subcontractor hereunder relating to a Patent Rights Clause in any subcontract.

31 COPYRIGHT

(a) The Contractor agrees to and does hereby grant to the Government, and to its officers, agents and employees acting within the scope of their official duties, (i) a royalty-free, nonexclusive and irrevocable license to reproduce, translate, publish, use, and dispose of, and to authorize others so to do, all copyrightable material first produced or composed and delivered to the Government under this contract by the Contractor, its employees or any individual or concern specifically employed or assigned to originate and prepare such material; and (ii) a license as aforesaid under any and all copyrighted or copyrightable work not first produced or composed by the Contractor in the performance of this contract but which is incorporated in the material furnished under the contract, provided that such license shall be only to the extent the Contractor now has, or prior to completion or final settlement of the contract may acquire, the right to grant such license without becoming liable to pay compensation to others solely because of such grant.

(b) The Contractor agrees that it will exert all reasonable effort to advise the Contracting Officer, at the time of delivering any copyrightable or copyrighted work furnished under this contract, of any advancedly-held copyrighted or copyrightable material incorporated in any such work and of any invasion of the right of privacy therein contained.

(c) The Contractor agrees to report to the Contracting Officer promptly and in reasonable written detail, any notice or claim of copyright infringement received by the Contractor with respect to any material delivered under this contract.

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32. FILING OF PATENT APPLICATIONS

(a) While and so long as the subject matter of this contract is classified "Secret" or higher, the Contractor agrees that, before filing or causing to be filed a patent application disclosing any of said subject matter, it will refer the proposed application to the Contracting Officer for determination whether, for reasons of national security, such application should be kept secret or the issuance of a patent thereunder otherwise delayed, under pertinent statutes or regulations, and the Contractor agrees to observe any instructions given by the Contracting Officer in this regard, which instructions may include a direction not to file such application, or longer the Contracting Officer completes that such filing would jeopardize national security. If the Contracting Officer directs the Contractor not to file such application, the Contractor may submit to the Contracting Officer a written request, addressed to the Secretary, for reconsideration of such direction, for pending action by the Secretary, the Contractor shall observe such instructions.

(b) While and so long as the subject matter of this contract is classified "Confidential" or higher, and if the Contracting Officer determines that there is no other practical means for maintaining the security of said subject matter, the Contractor agrees to assign and convey to the Government upon request the entire right, title and interest in and to each United States patent application disclosing said subject matter and filed by or on behalf of the Contractor, the title to the assigned patent application to be held in trust by the Government, subject to revocation of the entire right, title and interest therein to the Contractor

(i) upon allowance of the said application and payment of the final fee, or

(ii) upon the mailing of notice by the Contracting Officer to the Contractor that disclosure of the subject matter of the application will no longer jeopardize security. Nothing contained in this paragraph shall (A) apply to any patent application assigned to the Government under any other provisions of this contract, or (B) enlarge or diminish the rights granted to or reserved by the Government or the Contractor with respect to said application or the invention claimed thereby, except to the extent expressly provided in this clause.

(c) While and so long as the subject matter of this contract is classified "Confidential"* the Contractor agrees to furnish to the Contracting Officer, at the time of or prior to filing or causing to be filed a patent application disclosing any of said subject matter, a copy of such application for determination whether, for reasons of national security, such application should be kept secret or the issuance of a patent thereunder otherwise delayed, under pertinent statutes or regulations; and the Contractor agrees to observe any instructions of the Contracting Officer in this regard.

(d) While and so long as the subject matter of this contract is classified "Restricted", the Contractor shall be governed by the provisions of the clause of this contract entitled "Military Security Requirements".

* or, "Restricted,"

33. PATENT INDEMNITY

The Contractor agrees to indemnify the Government and its officers, agents and employees against liability, including costs and expenses, for infringement upon any Letters Patent of the United States (except Letters Patent issued upon an application which is now or may hereafter be, for reasons of national security, ordered by the Government to be kept secret or otherwise withheld from issue) arising out of the performance of this contract or out of the use or disposal by or for the account of the Government of supplies furnished or construction work performed hereunder. The foregoing indemnity shall not apply unless the Contractor shall have been informed as soon as practicable by the Government of the suit or action alleging such infringement, and shall have been given an opportunity to present recommendations as to the defense thereof; and further, such indemnity shall not apply in any one of the following situations: (i) any infringement resulting from the addition to any such supplies of other supplies not furnished by the Contractor for the purpose of such addition; (ii) any settlement of a claim of infringement made without the consent of the Contractor, unless required by final degree of a court of competent jurisdiction; (iii) any claim of infringement arising from use or disposal outside the scope of any license limitation under which the Contractor is bound, provided that the Contractor has notified the Government of the limitation prior to first delivery under this contract; (iv) any infringement necessarily resulting from changes (other than the substitution of another standard commercial part or component manufactured or supplied by the Contractor) ordered pursuant to this contract, or from specific written instructions given by the Contracting Officer directing a manner of performing the contract not normally utilized by the Contractor.

The foregoing shall not apply to contract items or parts thereof, which are not standard commercial supplies.

34. OPTION TO TERMINATE FIXED OVERHEAD AMOUNT

(a) Either party to this contract shall have the option to terminate the operation of fixed overhead amount, as provided in clause 4(j) hereof, in the event that a reasonably accurate forecast of an overhead amount is determined to be impracticable. The option to terminate the use of fixed overhead amount for the future period shall be invoked on written notice, prior to the effective date of overhead amount revision for the next succeeding period. (b) Termination of a fixed overhead amount shall be evidenced by a supplemental agreement to this contract, providing for reimbursement of overhead on the basis of audited actual cost for the period subsequent to the date of termination under this clause.

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35. AUTHORIZATION AND CONSENT

(a) The Government hereby gives its authorization and consent (without prejudice to its rights of indemnification, if such rights are provided for in this contract) for all use and manufacture, in the performance of this contract or any part hereof or any amendment hereto or any subcontract hereunder, (including any lower tier subcontract) of any patented invention (i) embodied in the structure or composition of any article the delivery of which is accepted by the Government under this contract, or (ii) utilized in the machinery, tools or methods the use of which necessarily results from compliance by the Contractor or the using subcontractor with a. specifications or written provisions now or hereafter forming a part of this contract, or b. specific written instructions given by the Contracting Officer directing the manner of performance.

36. FOREIGN OPERATIONS

Notwithstanding the foregoing, the provisions of Clauses 9, 10, 11, and 29, herein shall not be applicable to such portions of the work as are to be accomplished outside the continental limits of the United States, its territories and its possessions. Such work will be performed in accordance with the laws and treaties in force and with the sovereignty of the territory having jurisdiction, and, further, the Contractor shall be charged with the notice and knowledge of such laws and treaties, which are public documents or of which copies have been furnished to the Contractor.

37. CAPTURE AND DETENTION

In the event any contractor personnel assigned to duty under this contract is found to be missing from his place of employment, whether or not such personnel hen actually was engaged in the course of his employment, under circumstances supporting an inference that his absence was due to the action of a hostile force or the force of any power not allied with the United States in a common military effort, or is known to have been taken prisoner, hostage, or otherwise detained by a hostile force or the force of any power not allied with the United States in a common military effort, the time spent by such personnel during such detention (which shall be construed to include the period until such personnel is returned to his place of employment, or to the United States, or is able to be returned to the jurisdiction of the United States, or death in fact is established by a finding by the Federal Security Administrator or other Federal Body having jurisdiction or by other evidence satisfactory to the Contracting Officer, or death can legally be presumed to have occurred) shall not be considered as time spent in the performance of services hereunder and the Government shall not be obligated to make any payment on account of such personnel except as provided in this paragraph. The Contractor is authorized to and shall enter into agreements with personnel hereunder to pay benefits to the extent not otherwise paid to such personnel in the event of, and during the time spent by such personnel during such detention, as construed above, which will equal the total wage due for such period of detention, as construed above, computed on the basis of wage rate being paid such personnel at the time of such detention. Claims for benefits shall be made under applicable law with the Administrator. In the event that the Contractor is obligated by agreements, authorized above, to pay and shall have paid benefits in an amount not paid or payable by the Administrator on account of such detention of such personnel, the Government shall pay to the Contractor, in respect of such personnel during the period of such detention, as construed above, such amount which when added to the amount paid or to be paid in respect of such personnel by the Administrator, whether to the Contractor or otherwise, will equal the total wage due for such period of detention, as construed above, computed on the basis of wage rate being paid such personnel at the time of such detention. Subject to the availability of funds therefor, the obligation of the Government to make payments provided for by this paragraph shall continue in effect during the period of such detention, as construed above, and shall survive the earlier expiration or termination of this contract.

38. LETTER CONTRACT

This is the Definitive Contract contemplated by the Letter Contract, designated Contract No. AF 18(600)-881, issued by the Government to the Contractor under date of 30 June 1953, and supersedes said Letter Contract, as amended. Work performed and payments made under said Letter Contract, as amended, shall be deemed to be work performed and payments made under this definitive contract. The date of the Letter Contract shall govern for determination of the priority status of this Definitive Contract. In the event of conflict between this definitive contract and said Letter Contract, as amended, this definitive contract shall prevail.

39. ALTERATIONS

The following alterations have been made in the provisions of this contract:

a. Clause 3, "Inspection," words are added by asterisk reference at the bottom of page 1.

b. Clause 14, "Termination," paragraph (b), words are added by asterisk reference at the bottom of page 4.

c. Clause 21, "Additional Provisions Concerning Government Property," paragraph (a), words are added by asterisk reference at the bottom of page 10.

d. Clause 32, "Filing of Patent Applications," appearing on page 19 of the General Provisions hereto, is amended by adding the following words to paragraph (c) after the word "Confidential" in the first line: "or, 'Restricted,'".

40. CONTRACTUAL CONTENTS

This contract consists of the Preface on page i, the Schedule on Pages ii through iv, containing Parts I through VII, the General Provisions on pages 1, 2, 2a, 2b, 3 through 13, 13a, and 14 through 22, containing Clauses 1 through 41, Signature Page 23, and Technical Exhibit "I" consisting of pages 1 through 9, Technical Exhibit "II" consisting of 2 pages, and DD Form 254, attached hereto.

41. APPROVAL

This contract shall be subject to the written approval of the Secretary of the Air Force or his duly authorized representative, and shall not be binding until so approved.

The rights and obligations of the parties to this contract shall be subject to and governed by the Schedule and the General Provisions. To the extent of any inconsistency between the Schedule or the General Provisions, and any specifications or other provisions which are made a part of this contract by reference or otherwise, the Schedule and the General Provisions shall control. To the extent of any inconsistency between the Schedule and the General Provisions, the Schedule shall control.

The Contractor represents that the aggregate number of employees of the Contractor and its affiliates is: ☒ 500 or more, ☐ less than 500.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written:

THE UNITED STATES OF AMERICA

By /s/ John R. Martin

JOHN R. MARTIN
Colonel, USAF
(CONTRACTING OFFICER)

WITNESSES

.....

PAN AMERICAN WORLD AIRWAYS, INC.
(CONTRACTOR)

.....

By /s/ Franklin Gledhill

NOTE—In case of corporation, witnesses not required but certificate below must be completed. Type or print names under all signatures.

FRANKLIN GLEDHILL

Vice President
(TITLE)

135 East 42nd Street, Chrysler Building
New York 17, New York
(ADDRESS)

NOTE—Contractor, if a corporation, should cause the following certificate to be executed under its corporate seal, provided that the same officer shall not execute both the contract and the certificate.

CERTIFICATE

I, H. Preston Morris ..., certify that I am the Secretary of the corporation named as Contractor herein; that Franklin Gledhill, who signed this contract on behalf of the Contractor, was then a Vice President of said corporation; that said contract was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

/s/ H. Preston Morris (CORPORATE SEAL)
(SIGNATURE)

TECHNICAL EXHIBIT "I"

Contract No. AF 18(600)-881

SPECIFICATIONS FOR WORK

Description
Management and Administration (Section I)
Range Operations (II)
Repair and Maintenance of Equipment and Property (Section III)
Support Operations (Section IV)
Range Engineering (Section V)
Government Furnished Equipment and Services (Section VI)

SECTION I - MANAGEMENT AND ADMINISTRATION

1. The Contractor management will be responsible for:

a. Management, supervision and planning of work under the Contract.

b. Compliance of all contractor personnel and contractor activities with the provisions of international agreements.

c. Compliance of contractor personnel and activities with applicable AFMTC police regulations.

d. Compliance with security requirements set forth in this contract and applicable Air Force and base security directives.

e. Rendering monthly and special reports covering performance, contractual difficulties and personnel, supply and fund utilization as directed by the Contracting Officer.

f. Compliance with applicable Government regulations covering the care and use of Government property.

g. Notification of all civilian personnel previously utilized by the Government in any function phased-in to the contract as to the action on their applications for employment by the Contractor, such notification to be given thirty (30) days prior to phase-in date for such function.

h. Such planning as is required to implement the expanded contract contemplated for FY 1955.

SECTION II - RANGE OPERATIONS

1. The Contractor will study and analyze the test requirements and formulate operational plans for conduct of the tests to meet test schedules.

2. The Contractor will establish methods and procedures for, and direct reduction of all flight test data for optical and electronic trajectory measuring systems. The Contractor will prepare data routines for high-speed digital computer (FLAC), program, direct and perform reduction of all telemetry data, maintain, repair and make modifications of all data reduction equipment and conduct continuous review and research for improved data reduction methods. The Contractor will prepare for publication, data reduction reports as required.

3. The Contractor will provide services for processing and printing of all metric, documentary and engineering film and oscillograph recordings exposed on the range and base. He will provide necessary still and motion photographic service for documentary and technical activities of contractors and the test range.

4. The Contractor will perform the range test control function and will operate all test equipment.

5. The Contractor will collect, reduce and transmit data from test findings.

6. The Contractor will maintain the existing Airborne Early Warning Equipment which will be operated by Missile Test Center personnel.

7. The Contractor will maintain and operate ground interference control at Cape Canaveral as directed. AFMTC will maintain and operate airborne interference control aircraft and equipment.

SECTION III - REPAIR AND MAINTENANCE OF EQUIPMENT AND PROPERTY

1. The Contractor will, except as otherwise directed by the Contracting Officer, arrange for or perform maintenance of all of the property, equipment, and all other Government Furnished Property delivered to and accepted by the Contractor for the purposes of this contract.

2. Maintenance of buildings and roads shall include only normal repair and upkeep and shall not include rebuilding, reconstruction, or resurfacing.

3. The Contractor will maintain non-standard equipment for which the Air Force normally does not have depot maintenance responsibility. On standard Air Force equipment which the Air Force normally has depot maintenance responsibility, the Contractor will perform organizational and field maintenance. Items on which the Air Force normally has depot maintenance responsibility will be returned to the depot for this maintenance.

4. Utilities, equipment and components of equipment, not repairable at stations, will be returned to AFMTC for repair at no cost to the Contractor. In the event this equipment cannot be scheduled for repair within a time not detrimental to range operations, the contractor may, upon approval of the Contracting Officer, have such items repaired, the costs in connection with these repairs to be reimbursable under the contract.

5. The Contractor will be permitted to establish requirements, maintain and store spare parts kits for items of equipment at Auxiliary Air Force Bases, such as special optical and electronic gear, generating plants, air-conditioning equipment and specialized motor vehicles; basic kits of small parts to be maintained at the stations where equipment is installed; and more complete kits of lower level usage items and larger units to be stored at PAFB for dispatch to the stations as required.

6. The Air Installations Shops at Patrick AFB will be utilized by the Contractor through the work order procedure.

7. The Contractor will train technicians for the maintenance of the submarine cable and cable stations.

SECTION IV - SUPPORT OPERATIONS

1. The Contractor shall provide all such base level support of supplies and services as are required, pursuant to this contract, for the management, operation, and maintenance of the Missile Test Range, utilizing facilities and related equipment furnished under this contract. In addition, the Contractor shall furnish such necessary base level support, at the aforementioned Auxiliary Air Force Bases of the Missile Test Range, as is required for personnel, other than the Contractors' or Sub-Contractors' employees, as authorized or approved by the Contracting Officer.

2. For the purposes of this contract, the requirements set forth above shall be applicable to those activities of the Missile Test Range for which operational status is accomplished pursuant to Phase I, Paragraph D, PART I - STATEMENT OF WORK of the SCHEDULE hereto, and shall include, but not be limited to, messing facilities, janitorial, security and police, fire protection, bus transport, first aid, missile fuel storage and handling, ground support for flight operations, sea-transport, operation of liquid oxygen plant and fuel dispensing units, and related services.

SECTION V - RANGE ENGINEERING

1. The Contractor will plan and develop required changes and/or additions, provide installation drawings as required, due to changes and/or additions subsequent to the starting date of this contract, make modifications to instrumentation equipment, supervise installation contractors at Patrick Air Force Base, Stations 1, 3, 4, 5, 6, and 7 to meet missile test requirements.

2. The Contractor will provide technical liaison and monitoring on development contracts and perform inspection and acceptance tests on non-standard instrumentation under procurement.

3. The Contractor will prepare technical specifications to be used as the basis for the procurement of required new instrumentation and services.

4. The Contractor will perform such in-house development and non-standard equipment fabrication as is directed or approved by the Contracting Officer. Such in-house development by the Contractor will be limited, in general, to minor modifications or equipment improvement effort.

5. The Contractor will provide essential information on facility requirements to permit the Government to prepare necessary design criteria and budget estimates.

6. The Contractor will plan, initiate procurement of, distribute, calibrate and maintain test equipment for the Test Center.

7. The Contractor will study and analyze the requirements of all test agencies planning to use the Missile Test Range, in terms of range capability to meet these requirements, formulate operational plans for the range based on the requirements of the using agencies. The contractor will schedule the activities to meet the missile test schedules, establish procedures and direct activities to obtain data from which to process and reduce data, and report results of missile flight tests.

8. The Contractor will prepare plans and cost estimates for the instrumentation and installations of same at Stations 8, 9, 10, 12 and such direction findings sites as are required.

9. The Contractor will do all land surveys to locate instrumentation that are required on those stations where they have taken over operations.

SECTION VI - GOVERNMENT FURNISHED EQUIPMENT AND SERVICES

1. The Government will fly, maintain and base aircraft incident to and required to support the Missile Test Range operation.

2. The Government will furnish MSTS transport for all GFE and all other sea transport required to perform this contract except transport for contractor furnished property and supplies and personal effects of contractor personnel and dependents.

3. The Air Force will transfer to the Contractor the necessary General Purpose and Special Purpose vehicles approved by the Contracting Officer. The maintenance of vehicles will be accomplished in accordance with AFM 77-1.

4. The AFMTC will continue to have the responsibility for the missile recovery function during the remainder of FY 1954.

5. Any instrumentation and/or modification of aircraft incident to tests will be accomplished by the Government at Patrick Air Force Base with technical supervision provided by contractor.

6. The Government will establish all policies and procedures for providing in-flight safety prior to launching, during flight and termination of flight; evaluate suitability of various in-flight safety devices, circuitry, plotting board charts, sky screens, communications and flight termination systems; approve proposed missile flight plans from a safety standpoint; serve as final authority on missile safety during flight. Government personnel will occupy only those positions requiring decision to launch or terminate flight.

7. Fuels will be delivered by the Government to storage areas. This applies not only to the Cape but to other Auxiliary Air Force Bases. At such bases fuels will be delivered at the beach.

8. The Government will establish first-order survey needs for the period of FY 1954.

9. The Government will supply fire protection and guards for convoys from Patrick Air Force Base to the Cape Canaveral Area.

SECTION VI (Continued)

10. Bus transport between Patrick AFB and Cape Canaveral will be operated by the Government.

11. Required storeroom space at PAFB to be determined, will be made available to the Contractor for storage of spare parts kits for specialized equipment, vehicles and operating equipment at stations.

12. The Government will furnish additional medical service and ambulance as required by firing schedule at Cape Canaveral.

13. Innoculations for contractor personnel processing for downrange assignment will be provided by the Government at PAFB in accordance with AF Regulations.

14. Special Medical examinations required for contractor personnel, i.e., fuel storage personnel, will be furnished by the Government at PAFB in accordance with AF Regulations.

15. Chemical analysis of special fuel stored at the Cape will be performed by the Government at the PAFB Chemical Laboratory as required.

16. The Government will furnish emergency hospital and medical services for contractor personnel flown in to PAFB as emergency cases from downrange stations in accordance with AF Regulations.

17. Contractor will be provided with a storage area (new building now under construction) adjacent to the TSL for a consolidated service center storeroom for TSL. This storeroom will be used for bench stock expendable items and specialized parts issued by Base Supply and/or procured by the Contractor for use in the TSL Area.

18. The Contractor will draw stock items from Base Supply as required for use or to replenish spare parts kits.

19. The Government will provide necessary office and work space and utilities at PAFB and will provide maintenance, janitor service, fire protection and security service for such space and the related utilities.

SECTION VI (Continued)

20. The Government will furnish commercial electric power to the Contractor at Cape Canaveral.

21. Basic indoctrination of contractor personnel in Test Range mission and downrange briefing will be furnished by the Government.

22. During FY 1954 USAF will be responsible for weather officer coverage at Cape Canaveral and for planning and launching forecasts for missiles, for operating all required rawinsonde sections, including the one at Patrick AFB, and for taking all surface observations required for missile operations, and providing storm warnings and hurricane warnings for all AFMTC Downrange sites.

23. The Government will furnish normal communication service to the Contractor as may be available at Patrick Air Force Base. The Contractor will reimburse the Government, in accordance with established procedures, for any and all toll, installation, or other communication charges incurred by the Contractor and charged to the account of the Government. Any such charges which are properly allowable items of cost under this contract shall be reimbursed to the Contractor.

24. The Government will retain at Patrick Air Force Base, and make available to the Contractor, all existing specifications, drawings, and technical data relating to Range installations, operation, and maintenance.

Technical Exhibit "II"
Contract No. AF18(600)-881

CONTRACTOR PHASE-IN SCHEDULE
RANGE OPERATIONS
AFMTC
PERCENTAGE PHASE-IN

	1953			1954			
FUNCTION	DEC.	JAN.	FEB.	MAR.	APR.	MAY.	JUNE
MANAGEMENT	100						
PLANNING AND PROCEDURES	30	60	90	100			
CONTRACT ADMINISTRATION	100						
INDUSTRIAL RELATIONS	90	100					
SUPPLY DEPARTMENT	50	75	80	85	90	100	
ACCOUNTING DEPARTMENT	40	45	50	55	75	90	100
RANGE STATION ADMINISTRATION	10		20	30	60	90	100
CAPE CANAVERAL AAFB:							
ADMINISTRATION	50	75	100				
TEST OPERATIONS	40	100					
LAUNCH AREA	20	100					
SECURITY	10	100					
FIRE DEPARTMENT		50	100				
COMMISSARY	75	100					
PLANT MAINTENANCE:							
ADMINISTRATION	50	100					
BLDGS. & GROUNDS	10	100					
UTILITIES	10	100					
MOTOR POOL	10	100					
LIQUID OXYGEN PLANT					100		
FUEL DISPENSING UNITS			100				
CABLE MAINTENANCE			20		40	80	100
MISSILE RECOVERY						50	100
GBI AAFB				10	50	75	100
ELEUTHERA AAFB				10	50	75	100
TECHNICAL SYSTEMS LABORATORY AND ALLIED FUNCTIONS:							
MANAGEMENT AND STAFF	100						
PLANNING AND PROCEDURES	50	75	100				
RANGE OPERATIONS:							
ADMINISTRATION	30	75	100				
OPTIC MACHINE SHOP	50	75	100				
RADAR SHOP	65	80	100				
DEVELOPMENT SHOP			100				
INSTRUMENT REPAIR SHOP	90	100					
DATA REDUCTION	60	70	100				
PHOTO LABORATORY	50	75	100				
CAPE CANAVERAL AAFB	50	70	90	100			
GBI AAFB				10	50	90	100
ELEUTHERA AAFB					10	50	100

	1953	1954				
FUNCTION	DEC.	JAN.	FEB.	MAR.	APR.	MAY.	JUNE
RANGE ENGINEERING:							
ADMINISTRATION	50	80	100				
COMPUTER GROUP	45	90	100				
COMMUNICATIONS GROUP	50	80	100				
TELEMETRY AND TIMING GROUP	55	75	100				
OPTICS GROUP	60	75	100				

DEPARTMENT OF DEFENSE
SECURITY REQUIREMENTS CHECK LIST

1. DATE: 27 January 1954
2. SHEET 1 OF 1 SHEETS

3. U.S. CONTRACT OR TASK NO.	4. HIGHEST CLASSIFICATION INVOLVED IN THIS CONTRACT	5. CONTRACTOR'S NAME	6. CONTRACTOR'S ASSIGNED NO.
AF18(600)-881	*	Pan-American World Airways, Inc.	

7. THIS SHEET PERTAINS TO	8. CLASSIFICATION OF END ITEM OR COMPONENT (as checked in preceding item)	9. NO. OF APPENDAGES INCLUDED
☐ AN END ITEM ☐ A COMPONENT Not Applicable	Not Applicable	None

10. THIS SHEET REFERS TO (Enter nomenclature, drawing reference or other adequate identification of End Item or component covered)

Services Type Contract

BLOCK	CLASSIFICATION OF	TOP SECRET	SECRET	CONFIDENTIAL	RESTRICTED	UNCLASSIFIED
1	CONTRACT OR TASK DOCUMENTS					X
2	MODEL DESIGNATION, NOMENCLATURE, OR IDENTIFYING DESCRIPTION OF ITEM OR TASK					X
3	SPECIFICATIONS					X
4	DESIGN INFORMATION (Engineering notes, computations, etc.)		NOT APPLICABLE			
5	DRAWINGS OR SKETCHES					
	A - COMPLETE SET					X
	B - OF GAGES		NOT APPLICABLE			
	C - OF TOOLING		*	*		
	D - OF TEST EQUIPMENT		*	*		
	E - OF INSTALLATION OR ASSEMBLY		*	*		
	F - SKETCHES DESCRIBING PRINCIPLE INVOLVED		*	*		
	G - OTHER		*	*		
6	PHOTOGRAPHS					
	A - INTERNAL, CUTAWAY OR EXPLODED VIEWS		NOT APPLICABLE			
	B - EXTERNAL VIEWS		*	*		
7	PRODUCTION AND PROCUREMENT INFORMATION					
	A - NUMBERS TO BE PRODUCED		NOT APPLICABLE			
	B - RATES OF DELIVERY		*	*		
	C - ITEMS ON HAND		*	*		
	D - OVERALL DOLLAR OR UNIT COST		*	*		
	E - RAW MATERIAL USAGES		*	*		
	F - LIST OF SUB-CONTRACTORS		*	*		
	G - SPECIALIZED MANUFACTURING TECHNIQUES		*	*		
	H - OTHER		*	*		
8	REPORTS					
	A - STATUS AND PROGRESS *					
	B - TECHNICAL *					
	C - OTHER *					
9	MANUALS, HANDBOOKS, ETC.					
	A - MAINTENANCE		NOT APPLICABLE			
	B - OPERATIONAL		*	*		
10	PERFORMANCE INFORMATION AND TESTS					
	A - TESTS *					
	B - TEST DATA *					
	C - MILITARY PERFORMANCE OR OPERATIONAL CHARACTERISTICS *					
	D - OTHER *					

DD FORM 1 FEB 52 254 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

*In accordance with DD Form 254 contained in contract/s of Missile Contractor performing tests.

BLOCK	CLASSIFICATION OF	TOP SECRET	SECRET	CONFI-DENTIAL	RESTRICTED	UNCLAS-SIFIED
11	WRITTEN OR ORAL REFERENCE TO					
	A - CONTRACTOR					X
	B - NOMENCLATURE					X
	C - U.S. CONTRACT NUMBER					X
	D - U.S. CONTRACT NO. AND CONTRACTOR					X
	E - NOMENCLATURE AND CONTRACTOR					X
	F - U.S. CONTRACT NO. AND NOMENCLATURE					X
	G - U.S. CONTRACT NO., NOMENCLATURE AND CONTRACTOR					
12	MANUFACTURING AIDS					
	A - MODELS	NOT APPLICABLE				
	B - MOCK-UPS					
13	NAME PLATES, UNATTACHED OR ON ORDER					
14						
15						
16						

17 CLASSIFICATION OF ASSEMBLY WORK IS DETAILED ON APPENDAGES AS FOLLOWS

	ITEM, OR COMPONENT (Describe)	SEE CHECK LIST SHEET NUMBER	SEE APPENDAGE NUMBER
A			
B			
C			
D			
E			
F			

10 REMARKS
NOTE: DD Form 254-1 is not applicable to this procurement inasmuch as it is primarily a Service type contract.

ABOVE SECURITY REQUIREMENTS APPROVED BY DEPARTMENT OF DEFENSE REPRESENTATIVE		
NAME AND TITLE (Typed) H. HUBER Chief, Research Contracts Division	SIGNATURE H Huber	
BUREAU OR OFFICE Air Research and Development Command	DEPARTMENT Air Force	CODE RDMPE

INSTRUCTIONS

1. The "Security Requirements Check Lists" will be *USED BY THE CONTRACTING* activities of the Department of Defense to indicate the security classifications assigned to the various documents, materials, tasks, subcontracts, and sub-components of classified prime and sub-contracts. It requires the contracting activities to assign the necessary security classifications to the various phases of a classified contract or task and to indicate such security classifications in the appropriate columns.

2. *OVERCLASSIFICATION SHALL BE AVOIDED.* The prime purpose of the Check List is to reduce security clearance requirements and at the same time preserve a proper safeguarding of classified matter. The Check List is further intended to eliminate the concept that a security classification assigned to a classified contract or task applies equally to all phases of such contract or task. This analysis of security classification by components informs the contractor, sub-contractor and Department of Defense activities of the specific information which is classified and the degree of security protection required. The lowest security classification consistent with adequate security protection of the information concerned should be assigned.

The notation on this Check List that any item is unclassified does not constitute authorization for the release of that item, or information concerning it, to the public.

3. The Check List, consisting of a single sheet or multiple check list sheets with appendages, will be prepared by the Department of Defense activity responsible for the award or approval of each prime and sub-contract involving classified security information. The responsibility for the preparation of the Check List will be that of the Contracting Officer. The physical preparation thereof will be made by the engineering staff thoroughly familiar with the security requirements of the contract or task.

4. Contractors will consult with local Department of Defense representatives of the contracting activity concerning any questions of the detailed security requirements to include the security classification of subcontracts, if required.

5. Amendments or changes to the original contract, or part of subcontract, shall be classified in accordance with their contents and not necessarily in accordance with the security classifications contained in the original Check List(s).

6. Check Lists sheets of components will be reproduced by the contractor and furnished sub-contractors who are processing components.

7. The use of asterisks is recommended when amplification of a block heading or line is desired. Additional spaces on the form are provided for security classifications of items which cannot be properly assigned to standard items listed on the check lists.

8. Should the descriptions *(Item 10 of heading or in Block 17)* be determined to be classified by reference to Block 8, or any other item, the Check List sheet will be classified accordingly.

9. *PROCEDURES FOR PREPARATION OF CHECK LIST SHEETS.*

a. *HEADING:* Item 1 - Self-explanatory.

Item 2 - Insert the total number of Check Lists sheets used, upon the completion of the classification analysis. *(Example: If Check Lists sheets were prepared covering End Items and 4 components, fill in on last Check List sheet "Sheet 4 of 4 Sheets.")*

Items 3, 4 and 5 - Self-explanatory.

Item 6 - The contractor will insert the identifying number he may assign to the contract, if any.

Item 7 - Check the applicable one of the two blocks provided.

Item - Self-explanatory.

Item 9 - Write in the number of appendages to this *CHECK LIST SHEET. (The Appendages will be identified by using Check List sheet number-hyphen-letter.)*

Item 10 - Identify Item or Component, to which this particular Check List sheet pertains. If by reference to Block 8, the descriptions of the item or component is found to be classified, then this particular Check List Sheet should also be classified.

b. *BLOCKS: (Body of Form)* Block 1 - Refers to documents only. "Task" is a Department of Navy designation of an element or phase of a contract.

Block 2 - Refers to a description of the particular End Item or Component under analysis.

Block 3 - Refers to specifications *(or technical requirements)* prepared by Contractor or furnished by the Contracting Officer.

Block 4 - Self-explanatory.

Block 5 *(NOTE: This also includes sketches which the Navy refers to as "Plans".)* - A complete set of drawings will be classified at least to the highest security category of an individual drawing within the set. When an individual drawing is withdrawn from the set, the security classification shall be that upon the drawing, *PROVIDED* the legend or other markings on the drawing do not reveal information of any description that carries a higher classification. A complete set of drawings may be classified higher than the highest security category of an individual drawing within the set. Sketches will be classified, according to corresponding drawings in the complete set.

Block 6 - Self-explanatory.

Block 7 - If desired, a line may be drawn across the heading of this block line in order to give a single over-all classification of all individual items in this block. If this is done, it will also be necessary to designate the security classification of the individual lettered sub-lines.

E. This line should be filled out to assist the contractor in resolving any doubt as to classification. It will normally be "UNCLASSIFIED".

G. Refers to processes and manufacturing techniques employed by the Contractor. If the Contractor considers certain phases of manufacturing technique contain "proprietary processes", he should recommend as appropriate classification, usually CONFIDENTIAL.

Block 8 - Self-explanatory.

Block 9 - Includes manuals, handbooks, catalogues, etc., prepared by the contractor.

Block 10 - Self-explanatory.

Block 11 - The items A, C and D should normally be "UNCLASSIFIED".

Blocks 12 and 13 - Self-explanatory.

Blocks 14, 15 and 16 - To be used when additional space is required.

Block 17 - This block is intended to be a bibliography of all Check List sheets and appendages pertaining to the contract involved.

Block 18 - Self-explanatory.

APPENDIX TO SECURITY REQUIREMENTS CHECK LIST, DD FORM 254-1. This supplement form of the Check List is of utmost importance. The proper assignment of security classification "WITHOUT TALLY COUNT" and "WITH TALLY COUNT" will materially assist the Contractor *(and sub-contractors)* in determining the number of personnel working on assembly lines, who will require clearance *(see Note 1 of Appendage form)*. Unless a careful analysis of the security features of assembly work is made, the possibility of overclassification will likely occur with the result that impairment of production schedules will be caused by unnecessary clearance requirements. STUDY THE NOTES, ADD OTHER EXPLANATORY NOTES WHEN DEEMED APPROPRIATE, TO THOROUGHLY ACQUAINT THE CONTRACTOR WITH THE SECURITY CLASSIFICATION REQUIREMENTS.

* U. S. GOVERNMENT PRINTING OFFICE : 1958 O - 493245

Mr. ANFUSO. At that time weren't you one of the generals who opposed the transfer from the Air Force to Pan American?

General SCHRIEVER. No, sir; I was in the Pentagon at that time, and this was not within my province at all.

Mr. ANFUSO. Well, you know that there were generals in the Air Force who were opposed to the transfer?

General SCHRIEVER. Well, I would say almost anything that comes up there are generals that are opposed to it.

Mr. ANFUSO. Well, let me put it this way: One of the reasons given for the transfer was the ineptness and the inefficiency in the Air Force. Do you think that there was inefficiency and ineptness in the Air Force at the time of this transfer?

General SCHRIEVER. No, sir; I do not. I think there is a great deal of difficulty, however, in maintaining stability in your operation with military petrsonnel because of the turnover, the length of tours. You bring people in, you train them for this, and then they leave the service, and you start all over again.

Mr. ANFUSO. Well, then, you say, sir, that you certainly do not admit that there was ineptness and inefficiency in the Air Force?

General SCHRIEVER. I will certainly not admit to that.

Mr. ANFUSO. I will go along with you. And won't you say, sir, that the Air Force was completely competent and capable of running and conducting the base?

General SCHRIEVER. I would say that the Air Force could operate the facility; yes, sir; definitely.

The CHAIRMAN. Let me interrupt there a moment. I know what the gentleman is interested in because he has spoken to me in reference to an investigation of the operations of Pan American in that area. But I think in all fairness to the other members who haven't had a chance to talk to the general and ask him any questions, that such questions ought to be confined to the investigation of Pan American, if the gentleman will go along with me.

Mr. ANFUSO. I will go along with you, and I will not ask any further questions.

Mr. MCDONOUGH. Mr. Chairman.

Mr. ANFUSO. Just one more, if you don't mind.

The CHAIRMAN. All right.

Mr. ANFUSO. This second failure, General, you attributed to personnel error in not closing the valve. Who was in charge of the personnel?

General SCHRIEVER. Well, the test conductor on all of the Atlas flights is Convair. Of course, there is an officer there, the ballistic Missile Division has a field office there, and we have a project director down there for each of these three programs (Atlas, Titan, Thor), the Air Force project director has the final veto, if anything comes up. He is there in the blockhouse, but the test conductor runs the show, and that is a Convair man.

Mr. ANFUSO. I want to close by saying I have the highest confidence in General Schriever and the work he is doing. I think he is extremely competent, and I have the same confidence in General Yates, who is in command there—isn't he?

General SCHRIEVER. He is in command of Patrick; yes, sir.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. General, were the five failures or malfunctions that you cite in each case different or in some cases similar?

General SCHRIEVER. As I have pointed out, three of them were unrelated—different in each case. Two of them were similar—definitely related and we feel occurred for the same reason.

Mr. MCDONOUGH. In other words, referring to the two of the same character, the first time, you failed to correct the error in the next shot?

General SCHRIEVER. Well, what happened was we had 12 flights. We actually had nine flights where we had separation of the booster engines and the skirt, and never had a failure of the type that I am talking about as being related. Then we had a failure where we had this very severe fuel leak at separation.

Mr. MCDONOUGH. Now, was that fuel leak the result of the contracting agency in proposing the rocket for flight, or was it the failure on the part of the command on the post in arranging and ordering the flight?

General SCHRIEVER. No; at that time we didn't know exactly what caused it. It might have been a rupture in a tank or a valve not closing at separation, or some other failure that occurred at the time of separation. This would not have been the fault of any individual. It could mean that there might have been a design weakness at that particular point.

Mr. MCDONOUGH. Which hadn't occurred before?

General SCHRIEVER. Which had not occurred before; that is right.

Mr. MCDONOUGH. But had the same material been used in previous shots?

General SCHRIEVER. The same material had been used on two of the nine that I have talked about; yes.

Mr. MCDONOUGH. And they had not failed?

General SCHRIEVER. No, sir; they had not failed.

Mr. MCDONOUGH. And then the same material did fail at a subsequent shot?

General SCHRIEVER. That is right. Then we had the three failures which I described as being unrelated before we had another one of the same type that I have mentioned as being related; in other words, a fuel leak which occurred at separation with subsequent explosion of the missile. This is the fix that we have now made which we hope will correct that particular deficiency.

Mr. MCDONOUGH. You spoke about the shearing of the bolts.

General SCHRIEVER. On the launcher, yes, the launch arm.

Mr. MCDONOUGH. Now, wasn't there a study made as to the strength, the tensile strength of the material in those bolts, or what they would have to sustain under the circumstances?

General SCHRIEVER. There certainly is, and I think the point here is that we had 23 launchings, which means that—and there are 2 of these on each launch—there had been 46 successful operations of this.

Mr. MCDONOUGH. With the same material?

General SCHRIEVER. The same material exactly.

Mr. MCDONOUGH. Then you had a sudden explosion that put additional stress on the bolts and they failed?

General SCHRIEVER. I can show you pictures in executive session and show you what actually did happen to these particular bolts. We did not find this condition in any of the other launchers.

Mr. MCDONOUGH. Do you have any suspicion of a question of security, any intentional error that may occur through the operation of anybody on the base?

General SCHRIEVER. We are always extremely concerned about this. And this, of course, is a most difficult and sensitive area. I can assure you that we are extremely concerned. We are well aware of the possibility of sabotage and we have made a number of checks—not just by our own people, but by other agencies, in connection with this. To date we have found nothing that we could put our finger on of the kind that you have reference to.

Mr. MCDONOUGH. Well, I am thinking not only of the people on the base, but the material that is shipped in to you from some source that you have to assemble there. We are unfortunately subject to a decision of the Supreme Court that these people cannot be screened for their loyalty. That, in my opinion, jeopardizes this kind of a program, together with all of our other defense operations, and of course, you couldn't be held responsible for that. Under the circumstances, these people are free to operate without any test of their loyalty.

General SCHRIEVER. Well, let me say that we have had a number of incidents where we suspected that it might have been sabotage. We checked each of these incidents very, very thoroughly and in detail. The quality control system with respect to these missile programs is a very well-managed and very tight program. We can check a part back from the time it left a vendor and everything that happened to it, right on up to the installation in the missile. In every case we have found that it was not intentional. It was a personnel error. There was no reason to suspect that sabotage had in fact occurred.

Mr. MCDONOUGH. Now, do you consider in each of these five failures that these were experimental flights, they were not operational to the point that we were certain of them?

General SCHRIEVER. Not operational.

Mr. MCDONOUGH. In other words, there was a possibility of error in every case?

General SCHRIEVER. Well, they were test flights. Whenever we launch a missile on a test flight they have been gone over with a fine-tooth comb, and we expect them to work.

Mr. MCDONOUGH. Well, if there is something new in the setup, either new propulsion material, new valve setup, new release material for separating the rocket, and so forth, there is a possibility of failure. The thing that I am trying to get at is how many times you have shot the Atlas with material that you knew had previously worked well, and still it failed? Maybe that is a hard question to answer.

General SCHRIEVER. Well, I would have to check. We had, for example, in the B-series flights three successful flights in a row, in one case, and then we had a failure.

Mr. MCDONOUGH. Using the same material?

General SCHRIEVER. Exactly the same basic material. We had different test objectives. You see, you can only instrument a missile up

to a certain point. We have different objectives on different flights, although we will in certain cases allocate two or three missiles, perhaps, to the same set of test objectives. In this way we get not only one sample but we check through the particular set of objectives several times. We also have to grind into our planning here a certain number of failures for which we can't forecast the cause, but, generally speaking, the test objectives vary on flights even of the same period. Now, on the D-series flights, we have different test objectives on different flights. Not on every flight, but they will vary throughout the whole series of D-flights.

Mr. McDONOUGH. What is the difference between A, B, C, and D flights?

General SCHRIEVER. The A series had only the booster engines. They did not have the middle engine, which is the sustainer, and we did not separate or stage, with the A series flights. The A-series test objectives were aimed at testing the propulsion system, the structure, the automatic pilot, and so forth. This was really testing out the basic vehicle.

The B series was the first one that was a complete missile with guidance, nose cone separation, everything installed. The B series flights were complete missile flights. However, the skin gage on the tank was just a very, very little bit greater than the skin gage on the C and D series missiles. Also, as I have pointed out, changes were made in the engine compartment in the C and D, mostly in the D series.

The D series is the operational version. Of course, when we fire them at Patrick, they are heavily instrumented. We are checking what is really happening, and we get all of this data back through telemetry. On the flight that we had the other day, we recovered the complete nose cone from right off of Ascension Island. There was a great deal of data that we got through telemetry from the nose cone, but getting the physical article back is very helpful in seeing exactly what happened.

Mr. McDONOUGH. Have any of these failures occurred as a result of not pretesting the material, the new material that may be used in the rocket?

General SCHRIEVER. No, sir; we have an extensive ground test program before we ever flight-test any of this equipment.

The CHAIRMAN. Any further questions?

Mr. WOLF. Mr. Chairman.

The CHAIRMAN. I don't mean to cut anybody off, but the time is moving on and we have to close at noon.

Mr. Wolf.

Mr. WOLF. I had wanted to delve into this question of sabotage a little bit. You say you had 23 successful firings?

General SCHRIEVER. No, I was talking about the launcher.

Mr. WOLF. Where this did not fail? I didn't understand.

General SCHRIEVER. Where the launcher did not fail.

Mr. WOLF. But you had a series of uninterrupted successful launchings, as I understood you?

General SCHRIEVER. We started the B series testing, which was the complete missile, last June. Wasn't it?

Colonel CRISTADORO. In August.

General SCHRIEVER. Just about a year ago, and we had 12 flights, of the B series, of which 8 were completely successful, and then we had this series of unsuccessful flights.

Mr. WOLF. With regard to this method of checking. Now obviously, there must be some sort of routine check of the last-minute details. Is it possible that after these last-minute checks are made somebody who would understand the mechanisms would be floating around? We have attended some of these flights, and there are about a hundred people floating around, quite often in the dark. After this checked out could someone——

General SCHRIEVER. No, sir, this would have been impossible.

Mr. WOLF. Do you sincerely believe, then, that sabotage is not the question?

General SCHRIEVER. Well, it would be a good excuse if I could use it.

Mr. WOLF. That is what I wanted to hear you say, but you do not feel this is the excuse?

General SCHRIEVER. No.

Mr. WOLF. Well, that is about all that I had in mind to discuss.

General SCHRIEVER. I wouldn't rule anything out, but whenever we suspect anything we go after it tooth and nail. We haven't found anything that we could hang our hat on in this regard.

Mr. WOLF. I have every confidence you will have some successful firings.

The CHAIRMAN. Mr. Chenoweth.

Mr. CHENOWETH. General, I have been very pleased with your optimistic statement. I think everyone realizes the important role you are playing. I join with the other members of the committee in congratulating you on what you are accomplishing. Where are the experiments being done on Atlas? Is that at Vandenberg?

General SCHRIEVER. No, sir, all of the flight tests have been conducted from Cape Canaveral, but I would like to get into the record here that that is only one small part of the testing that we do on the Atlas. We have near San Diego, at Sycamore Canyon, two of what we call captive test stands. We put a complete Atlas missile on these stands and run firing tests on it there.

We attempt to simulate as best we can all of the flight conditions. Of course in the final analysis this is impossible, but we can simulate to a great extent the conditions that occur in flight.

Mr. CHENOWETH. As I understand it, Atlas is prepared at Vandenberg—the mechanical work?

General SCHRIEVER. No. The Atlas is assembled at San Diego.

Mr. CHENOWETH. At San Diego?

General SCHRIEVER. Yes; now, in addition to these captive test facilities at San Diego—are those which we have at Edwards Air Force Base, where we have a large rocket test facility. So we do a great deal of testing of this missile, through what we call captive testing—testing in a holddown condition, where we run full-duration firings on the missile.

Mr. CHENOWETH. Where do you do that, do you say?

General SCHRIEVER. That is done near San Diego, at Sycamore Canyon, and at Edwards Air Force Base, Calif., at our rocket test base there.

Vandenberg Air Force Base is our first operational base. Our first operational launch facilities have been completed there. As a matter of fact, the missiles are in place on those launch facilities. Vandenberg has a double-edged mission, as far as the Air Force is concerned, as it relates to missiles: First, it is the major Air Force training base for operational crews; and secondly, it does have an operational capability.

In other words, the missiles could be fired from Vandenberg as operational missiles against an enemy.

The CHAIRMAN. Will the gentleman yield?

Mr. CHENOWETH. Yes.

The CHAIRMAN. We don't want to go into the question of operations with this witness because it has been brought to our attention it is not within our jurisdiction.

Mr. CHENOWETH. I was just curious to get some of this information.

General SCHRIEVER. I know there is some confusion as to what role Vandenberg plays, and I just wanted to make that clear.

Mr. CHENOWETH. I am glad you cleared that up. You do all of your full-dress firing at Cape Canaveral, then, on the Atlas?

General SCHRIEVER. Yes; research and development flight testing. I do want to point out, since this committee is interested in space, that we do have an R. & D. test program on space flights at Vandenberg. All of our Discoverer flights are launched from Vandenberg. Also most of our satellite work will be done from that area.

Mr. CHENOWETH. The counterpart of the Atlas is Thor?

General SCHRIEVER. No; the complementary program to the Atlas is the Titan. It is a two-stage missile.

Mr. CHENOWETH. That has been manufactured by Martin, in Denver?

General SCHRIEVER. Yes.

Mr. CHENOWETH. The Titan is the counterpart of the Atlas?

General SCHRIEVER. It is an ICBM. It has a 5,500-nautical-mile range. The Thor is an IRBM, it has a 1,500-nautical-mile range.

Mr. CHENOWETH. How would they compare in size?

General SCHRIEVER. In gross weight they are about the same. The Titan is a little longer than the Atlas, but a little lighter. Titan is a truly two-stage system, whereas the Atlas is a stage and a half. We call this a stage and a half because only the two booster engines and the skirt separate. With the Titan, the separation occurs right at this point (indicating), and all of the first stage tankage and the two booster engines drop off. Another engine located at this point on the second stage is actually ignited in flight.

Mr. CHENOWETH. I wanted to ask you about the relative thrust. I don't know whether you wanted to discuss that in open session or not. I would be curious to know the thrust of the three.

General SCHRIEVER. I won't give you the exact—I don't know whether this has been released. The thrust is about the same in the two systems, although the engines are quite different in detail. Aerojet manufactures the engines for the Titan. The Atlas engines are manufactured by North American.

Mr. CHENOWETH. You say the thrust in all three then would be about the same, the overall thrust, in the Atlas, Titan and——

General SCHRIEVER. Yes, in the Atlas and Titan. The Thor has only a single engine. It is just one-half of the booster combination here for the Atlas.

Mr. CHENOWETH. I see.

General SCHRIEVER. It is essentially the same engine.

Mr. CHENOWETH. I think that is all, Mr. Chairman.

Thank you.

The CHAIRMAN. Mr. Hechler.

Mr. HECHLER. Mr. Chairman; General, could any of these failures conceivably be related in any way to lack of sufficient appropriation for training, personnel, or research in any specific field?

General SCHRIEVER. No, sir.

Mr. HECHLER. I notice on page 4 of your initial statement you refer and quote from the findings of an eminent panel of the Air Force Scientific Advisory Committee. I wonder if you just would briefly give us an idea of the personnel of this eminent panel?

General SCHRIEVER. Yes, I will. I will get the names for you in a moment. Do you have any other questions?

The CHAIRMAN. You can supply them later.

Mr. HECHLER. You could supply them for the record.

General SCHRIEVER. Well, I can give them to you. These people are members of the Advisory Committee on Ballistic Missiles, which has been in existence since the initiation of the program. This was a panel of that Committee. The particular members were Dr. L. A. Hyland, Dr. Charles Lauritsen, Charles Lindbergh, Dr. Clarke Millikan, and Dr. William Graham.

Mr. HECHLER. Now you mentioned, General, this report was made in mid-June. Do you have a more specific date or name for the report? I was just interested in having it identified.

General SCHRIEVER. Yes, it is called the Ad Hoc Group of the Intercontinental Ballistic Missile Scientific Advisory Committee to the Secretary of Defense. The meeting occurred on June 17 and 18, 1959.

Mr. HECHLER. Could you submit the complete report for the record, sir?

General SCHRIEVER. It is classified. We can submit it in executive session.

The CHAIRMAN. General, when we go into executive session we can take up the report.

Mr. HECHLER. Thank you, Mr. Chairman.

Mr. VAN PELT. No questions.

The CHAIRMAN. Mr. Daddario.

Mr. DADDARIO. General, you have referred to the calculated risk that exists in overlapping your developmental and operational programs, and I wonder if you have any thoughts as to whether or not some of these deficiencies which have occurred might not have been discovered if you had not overlapped them so much and if you had spent more time in the research and development program?

General SCHRIEVER. Well, of course, there are different opinions as to how one basically carries out a development program in terms of both cost and time. I, myself, believe that one should proceed as rapidly as possible. In other words, take a number of risks as you move along, but keep going and keep going as fast as you can. I feel

if we had carried out the program and had stretched out the testing, for example, the flight testing over a long period of time, you still would have run into similar problems and you would not have accomplished your development objectives as soon.

The reference I made to the overlap between development and operations I think is very important. You can give the developer a break, because he is always catching it in the neck from everyone anyway, by giving him a looser schedule.

In other words from the viewpoint of a developer only I would much rather say, "Well, I will give you a missile in 1960 or 1961," than to be fighting to try to get one in 1959. The point is that in our current political and psychological climate, that I think it is so important that we get at least an initial capability in being as early as possible, even though the initial reliability might be low for this type of weapons system. I firmly believe it was indeed the right thing for the Air Force, and the country, to do to attempt to push together the time and take the calculated risk of meeting the development milestones in a very compressed schedule, and at the same time doing all of the other things necessary to have the operational environment created and the people there to man it. This is what we have in fact done in the Atlas and are doing also in the Titan program.

Mr. DADDARIO. General, I recognize that there is—and you have pointed out—that there is a deep sense of urgency. You have just referred to the psychological atmosphere which has been created and the need to do things to overcome this type of feeling. Yet, at the same time, in your report you talk about the flight tests which are so important, and you refer to these as being something that we should not lose sight of.

Now, within this program, within your captive tests, aren't you still finding errors? Aren't you still learning something each day?

General SCHRIEVER. Oh, yes, we learn something each day, but it has been largely in the area of reliability, and not in any fundamental design sense.

Mr. DADDARIO. Well, then, as I understand it—so that I can get it clear—you believe that although you continue running your tests of your captive stages and your research, and that type of thing, that even though errors exist within that area, that you do not have any problems in overcoming these errors at the same time that you are actually performing free flights?

I just can't see how, while you are correcting errors in your research stage, that you can ever feel sure that some of those errors do not exist within the operational vehicle that you are sending out in free flight.

General SCHRIEVER. Oh, you mean problems that we find during the development phase, during our ground testing; is that what you are talking about?

Mr. DADDARIO. Yes.

General SCHRIEVER. Well, we find a lot of things that we want to change, based on our ground testing. We actually make changes, but they break down into different categories of changes. Some are mandatory changes and have to be made prior to any flight. Others are in the category of desirable changes and are brought in later. They are not necessarily dangerous to flight, but they are changes that

would give you perhaps a little better performance, or increase overall reliability, or decrease complexity, things of this kind.

We certainly never fly a missile if we have discovered something in our development testing on the ground which we consider dangerous to the flight. Now, you have to fly these missiles. You can test them on the ground until the cows come home. There is no way in which you really can, in the final analysis, learn whether these missiles will do what they are supposed to do unless you fly them.

Mr. DADDARIO. Well, you have reached the stage then where you believe what you learn on your captive tests is in the nature of improvement, rather than the creation of defects?

General SCHRIEVER. That is true, if you are thinking about defects in the sense that this would be dangerous to flight, yes, definitely.

Mr. DADDARIO. That is all, Mr. Chairman.

The CHAIRMAN. Mr. King.

Mr. KING. General, as I observe these tests—and I have had the opportunity of going down to Cape Canaveral and Redstone—it is always bewildering to see how many people have their finger in the pie, so to speak; different companies. You have mentioned Convair and Pan American, and, of course, the Air Force, itself, and they in turn are broken down into many subdivisions and lines of authority.

The CHAIRMAN. Mr. King, may I suggest this: If you want the press to hear your statement you better raise your voice a little bit. It would help us up here, too.

Mr. KING. All right, Mr. Chairman. You get the impression of a beehive swarming with many people with different assignments, but the thing that I wonder, as I see that, is whether there is one coordinated line of authority or direction, one "superbrain" that masterminds the whole thing and assumes direct responsibility for any defects that may occur. So I am wondering if you could discuss for a moment whether you think that there may not be too many people in positions of responsibility, whether there may not have been too much fragmentation of authority, rather than an attempt to unify authority, so that you could put the finger of responsibility at a specific place when something goes wrong.

General SCHRIEVER. Well, of course, you have pointed your finger at one of the most difficult management jobs that we have, and that is the conduct of test. We have had a great many problems in developing organizations and procedures which we consider to be entirely satisfactory for conducting the tests at Cape Canaveral.

There are a number of different agencies that have different responsibilities, but there is a clear line of authority, without any question, as it relates to the launching of the missile. For all of the things that relates to the launcher and all of the things that relate to the missile, there is a very definite and clear line of authority. The procedures are well established and they are well understood by everyone.

Mr. KING. Could I ask one question right there? On a ship you have the captain. There is no question that he is in command. There may be a lot of fragmentation under him, but if anything goes wrong there is no one else that he can pass the buck to; he is the captain, he is in charge. All of the lines of authority emanate from him, insofar as they relate to the operation of that ship.

Now, my question is, In a launching is there a captain of that launching, is there one man who assumes responsibility for the success of that launching and who coordinates all of the activities that might flow from him and under him?

General SCHRIEVER. Yes, there is, of course. And I will come back and discuss this in a moment. There is a great deal of work done prior to actually sitting down and launching. There is a test working group, and the chairman of that group is the officer who represents the Ballistic Missile Division at Cape Canaveral for that particular program. He is the one and final authority. He is in the blockhouse and he is overlooking and supervising the launch, this particular launch exercise. The contractor's test director actually conducts the details of the test. In other words, he is the one in the case of Atlas that represents Convair, and he is the captain in terms of actual details of directing the test, and everyone listens to him. He is the boss in terms of details.

But he has to follow exactly the procedure and take every step that has been written out with respect to the conduct of that test. The Air Force man who is right there is responsible to see that that is done. He is there to supervise it. He is the final authority. He can call a test off or he can make the decision to go ahead, short of range safety. On range safety considerations, the Air Force missile test center range safety officer has the final authority on that. But as to all other aspects of the test, the officer from the Ballistic Missile Division is the one who has the final authority, and he is a man in a uniform.

Mr. KING. But this other man you were referring to a minute ago——

General SCHRIEVER. The test director.

Mr. KING. The test director; he is a civilian, a Convair employee. Is that correct?

General SCHRIEVER. That is correct. He is a Convair employee, a civilian.

Mr. KING. But he is the boss, so to speak, he can tell men what to do, even men in uniform, Air Force personnel?

General SCHRIEVER. Well, there will be no Air Force personnel down at Cape Canaveral actually running any of the facilities there, as far as the test, the launch is concerned. These would all be civilians.

Mr. KING. Of course, this gets into the matter that Mr. Anfuso was delving into, and I don't want to pursue that.

General SCHRIEVER. There aren't any Pan American people involved in that.

Mr. KING. Let me just ask one question. Do you feel it is a good arrangement to have the actual operation of this blast off in the hands of civilians, with the military man merely overseeing the final result, or do you think that members of the Air Force should take a more direct and active participation in the details of the blast off?

General SCHRIEVER. Well, the contractors are responsible to the U.S. Air Force for developing the system, and during the development testing I think it is appropriate that they should be the ones who actually conduct tests.

Mr. McDONOUGH. Will the gentleman yield at that point?

Mr. KING. That is all I have.

Mr. McDONOUGH. Well, this Convair employee would not be present if we were at war and using this for defense purposes.

General SCHRIEVER. When we get operational at Vandenberg, there won't be any contractor personnel there. These missiles will be operated by the military.

The CHAIRMAN. Are there any further questions?

Mr. Hall, do you have any questions?

Mr. HALL. I have two, Mr. Chairman. Is the holddown mechanism the same mechanism, used for more than one launch, this part where you had the failure?

General SCHRIEVER. Yes, sir.

Mr. HALL. In other words, you can launch two or three rockets with that same holddown mechanism?

General SCHRIEVER. We plan to launch many rockets with the same holddown mechanism.

Mr. HALL. You don't happen to know how many launches had been made with that particular mechanism?

General SCHRIEVER. I had the record. I think six on this one.

Mr. HALL. That is all, Mr. Chairman.

The CHAIRMAN. General, I have been asked to ask you this question here: The failures that you have referred to in the course of this hearing, they have not changed our relative position with reference to Russia in the development of ICBM's and in the race for space?

General SCHRIEVER. In my opinion, it has not. I think if we do in fact have the fix now we will not have been affected, in my opinion.

The CHAIRMAN. But now if these failures continue—and we hope that they won't continue, and I know I voice the view of you and all of the members of the Air Force and the military—if they continue, they will ultimately affect our relative position with Russia, won't they?

General SCHRIEVER. There is no question about it, because the Atlas missile will be our first operational ICBM capability.

The CHAIRMAN. We are placing tremendous hope and responsibility in that missile, aren't we?

General SCHRIEVER. There is no question about it.

The CHAIRMAN. Because we are taking that not only for military purposes, but for the development of the space program under NASA and the peacetime use of that. Therefore, it is as important as any missile development that we have; isn't that true?

General SCHRIEVER. I would say at this point it is the most important because the space program depends to a very large extent on a successful Atlas program.

The CHAIRMAN. Now, of course, the Russians have had their disappointments, I know, but we haven't been able to get them out in the open. They are not in a goldfish bowl like we were, are they?

General SCHRIEVER. I wish they were.

The CHAIRMAN. Well, do you have any knowledge of any disappointments that you could give this committee? We would be delighted to hear it.

General SCHRIEVER. All I can say is they have had some.

The CHAIRMAN. They have had some that you know of?

General SCHRIEVER. Yes, sir.

The CHAIRMAN. Well, I think that is all; and let me voice the view of this committee, that we do have complete confidence in you, General. I am happy to see you in your new position here, and I think

the program is under most competent hands. We appreciate your coming here supported by Colonel Cristadoro and Colonel Boatman.

Mr. FULTON. Let me join in that statement of confidence in General Schriever and his staff.

The CHAIRMAN. Now, General, in reference to the off-the-record executive information that you have referred to, if it is satisfactory with you, since you are here in Washington, we would like to set that down for a future date. Tomorrow the Secretary of the Army is coming here and is going to give the committee a flag.

I want all of the members to know about it because he has a flag with 700 streamers on it which is going to be presented to the committee first thing.

Following that we will have a witness from the Navy on the Polaris missile, and if we may, we will let you know later on and have the executive features of this testimony.

Again, thank you very much, General.

General SCHRIEVER. Thank you, Mr. Brooks.

(Whereupon, at 12:04 p.m., the committee adjourned, to reconvene at 10:00 a.m., Wednesday, July 29, 1959.)

PROGRESS OF ATLAS AND POLARIS MISSILES

WEDNESDAY, JULY 29, 1959

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met, pursuant to adjournment, at 10 a.m., Hon. Overton Brooks, chairman of the committee, presiding.

The CHAIRMAN. Now, members of the committee, yesterday morning when we began these hearings looking into the successive failures or the malfunctions of the Polaris and Atlas missiles, I announced that the committee was undertaking this inquiry with no intention of criticism of the Air Force or Navy.

I iterate this, because, because the witnesses this morning were not present yesterday morning when that statement was made. I said then, and I repeat now, that we are not merely here to find fault, but rather to try to get information concerning our missile-testing difficulties and attempt to be of assistance to the armed services in this connection.

I also said this committee was not attempting to poach upon the jurisdiction of any other committee. We all realize fully when Polaris becomes operational it will be a military weapon, and thus not within the jurisdiction of the committee. However, so long as it continues in the research and development stage, I believe the committee has the jurisdiction and responsibility to determine the facts and the causes of recent flight test failures. But more than that, we are interested in Polaris because it is the first missile of any consequence that is using, or proposes to use, a solid propellant. As a consequence, this committee is extremely interested to know the Navy's views concerning solid propellants, as compared with liquid propellants. We are also interested in knowing if any of the malfunctions of the Polaris can be attributed to or traced to the type of propellant being used.

We are fortunate this morning in having with us Rear Adm. W. F. Raborn, Director of Special Projects of the U.S. Navy, and he will be followed by Dr. James McRae, member of the Secretary of Defense's Scientific Advisory Committee on Ballistic Missiles.

We have the privilege now of recognizing Rear Adm. W. F. Raborn, Director of Special Projects.

Admiral, you have a prepared statement here, and the committee will be happy that you proceed.

STATEMENT OF REAR ADM. W. F. RABORN, DIRECTOR, SPECIAL PROJECTS; ACCOMPANIED BY VICE ADMIRAL HAYWARD, U.S. NAVY

Admiral RABORN. Thank you, Mr. Chairman. With the chairman's permission, I would like to submit the statement for the record and to illustrate by means of the flight test program what we now have, and answer your questions.

The CHAIRMAN. You may proceed as you wish. If I may intrude further, Admiral, the members of the press—and they are here in large number this morning—ask that all of the members who ask questions speak up loudly so that they can hear what the questions are, and we will ask the witnesses likewise, to speak loud enough so that the press can hear.

We will be happy to invite the members of the press to come closer so they can see to write their notes.

Now, Admiral, without further interruption, we will invite you to proceed.

Admiral RABORN. Thank you, Mr. Chairman.

First I would like to say that we are delighted with the committee's interest and the opportunity to allow you to share with us the confidence which we have in our program. I would like, if I may, to tell you something about our program, because as you have already noted, it is a distinctively different missile development. And because of this we have had to evolve some rather unique test methods in order to obtain the information.

Now, perhaps a bit of history would be in order. As you know, about 3½ years ago we were partners with the Army in an attempt to use the Jupiter liquid fuel missile, and I would like to say here that we thoroughly enjoyed and appreciated this opportunity to associate ourselves with the U.S. Army in this technical development. We learned a lot from them and we learned to admire them even more than we did for their technical competence. Because it soon became apparent that we could not use liquid fuels in the confined spaces aboard ship due to the safety factors, and because this was a very large thin-wall missile which would be ungainly and unwieldy to handle aboard the rolling, pitching motions of a ship, we turned to investigations of what we might do to develop a solid propellent motor, two-stage motor, to propel the warhead of the Jupiter missile, that warhead guidance.

As you see, this would have been a very large missile, indeed, some 185,000 pounds, with these motors—there are seven of them in the first stage and one similar one in the second stage—you have a very grotesque missile, indeed, to handle aboard surface vessels and it would have been most impractical aboard submarines. So regretfully, we had to look elsewhere.

Now, fortunately, about this time we were acquainted with the splendid work of the Atomic Energy Commission in getting a very large-yield atomic warhead in a small package. Concurrently with that, the Navy had unusual success in its research efforts with the Atlantic Research Corp. to materially improve the specific thrust of the boost which we could get out of solid propellants. And the *Nautilus*, of course, was in existence, and it seemed a natural that we

attempt to tie the three together in a very usable weapons system, and this was done.

In order to bring this sharply into focus—and I apologize, I don't care to read all of these, but I just want to show this part down here [indicating].

We called together the brightest minds in industry, and in our technical laboratories, and over a period of 3 months we conducted intensive studies in these major elements of the entire weapons system, which included the missile, but it also included the launching and handling system, the reentry body, the equipment on the submarine to make the missile usable, the fire control, which takes the navigation information, converts it into useful information, in order that the missile may go to its target.

These separate study groups, working in their own areas, optimized parameters, physical as well as technical, and then the group as a whole optimized the parameters of the entire system. We looked ahead some 5 years and attempted to forecast the technical state of art which we could have some 5 years from then, and said: "Let us settle on those characteristics and build toward that, because as we always do, we learn more as we get along, and when we get this system it will be a modern and up-to-date system, the best that American technology can provide."

As a result of that, we were able to evolve a very small two-stage solid propellent missile shown here, and in direct comparison by size with the other missiles which we had been working with.

And so in effect, what we were doing was developing a two-stage large solid propellent missile and tying it to the nuclear-powered submarine typified by the lead which we had by the *Nautilus*. We concluded—and this speaks specifically to your question, Mr. Chairman—that the solid fuel Polaris is safer to transport, to handle, to store on shore or afloat, prepare for launching, and to launch from a ship in motion. And in comparison with liquid fuel missiles—and this answers your question again—we had detailed proof that we could get these elements in the solid fuel that we could not get with liquid, of greater safety, better operational readiness, because the solid propellent missile was already filled and did not need then to be filled in preparation for firing, far more suitable to shipboard use, and lower cost. Lower cost, principally, in that the size of the ship which is the launch site could be made considerably smaller. We could cut it down by at least a third over getting comparable hitting power in the larger missiles.

This, of course, effected a tremendous saving. I well remember the saving on the original program was $500 million, and this, of course, is a most significant sum. To do this job, the Navy created a Manhattan District type organization within the Navy called the special projects management team. We are weapons system managers in the true sense of the word. We give top business direction and top technical direction to the overall progress of this weapons system as a whole.

We are a small management team, and I would like to say here I think it is a high compliment to the Navy's organization that it can take an autonomous organization inside of it, support it in the splendid manner that they have, and have brought this along with minimum friction and difficulties to other naval programs.

I know that you are interested primarily in the missile, and I will speak of that at some length. However, I would like to highlight the fact that my office is responsible for the weapons system as a whole, and we have programs in human factors, recognizing as we do that when you shut yourself off from the normal earth's atmosphere for periods of 3 months at a time, up to 3 months at a time, you are in fact pioneering in some of the problems which will face space travelers in the future, and so there are physiological as well as psychological elements which we must take into account, and I am glad to say we have recognized this. And on my staff I have two qualified medical officers of the Navy and have had since the project's inception.

We are interested, of course, in communications and we have direct charge of that element of our program, the navigation, the fire control, and the launching, which is tied in directly and must be compatible with the requirements of the missile, and the requirements of the missile must be compatible with the launching requirements.

Now there is the ballistic shell, the guidance, the propulsion, and reentry, of which I will speak in a little more detail. I would like to tell you something about how we spotlighted our development problems at the very outset by this fine team of scientists and how we have evolved a method of carrying on this development, and then finally I would like to tell you where we are in our development cycle.

The major development problem areas which we spotlighted for ourselves 3 years ago are shown here—propulsion, flight control, the ballistic shell, the reentry, the guidance package, test instrumentation, in order to get the information necessary to tell us what we were doing, how we were doing it, what we should do, the launching, submerged launch, navigation of the submarine, communications, target location, and the general areas of missile subsystems, weight reduction, reliability, safety, and readiness.

Now, I will isolate, if you please, those which have to do with the missile. Weapons system testing goes into ground and flight test. We do the maximum amount on the ground because we have better instrumentation on the ground to get information, and to verify our calculations by actual test. We supplement the ground tests in initial stages by flight tests only to the extent absolutely required. If we do otherwise we would be handicapping ourselves.

Following that, of course, we get into more flight tests, and we do ground tests, and only to the extent necessary, to work out the problems or difficulties which have appeared in the flight tests. We get into flight and do flight tests by means of test vehicles, and do this only to the extent required by the development of the missile. Specifically, of course, then we have conducted ground tests and ground development in the reentry which had to do with the heating and attitude control of the reentry body, working directly with a team which my office and the Atomic Energy Commission has set up, Livermore Laboratory. I am most pleased to report to this distinguished committee that the Chairman of this Joint Navy-Atomic Energy Committee is a lieutenant commander, a doctor of physics, in my office.

He was chosen by popular acclaim by the participants, both civilian scientists and military scientists. I am pleased to say that the reentry body is in excellent shape. We have proven out to our complete satisfaction the problems incident to reentering the earth's atmos-

phere, but because of the very sensitive and classified nature of that I will withhold further comment until closed session, if you wish.

The CHAIRMAN. Admiral, may I interrupt you just to ask you this: Many of the problems—and I am looking at your diagram now—many of your problems, such as reentry, guidance, and propulsion, are problems that occur in the development of all other similar missiles; isn't that right?

Admiral RABORN. Yes; and I am going to tell you the peculiar problems that are applicable only to ours.

The CHAIRMAN. All right. Insofar as you are successful, for instance, in reentry, you contribute to all programs.

Admiral RABORN. We have drawn liberally, as all programs have, on the fine work done by other people in similar work. I am very glad to say that our exchange of technical information is of high order.

Mr. FULTON. Could you comment there that the work that you are doing, because of its broad base, is also helpful in the Mercury or the man-in-space program? These things that must be solved for the missiles designed for war purposes are also just as valid for peaceful purposes such as the man-in-space program. Is that not right?

Admiral RABORN. I am sure, Mr. Fulton, that is correct. In the problems of guidance we, of course, had to develop very small gyros, computer functional operation, and guidance-fire control integration. We have unusual problems—and this is speaking of the chairman's thought there—we have some very unusual problems when we build a very small but still relatively long-range ballistic missile, of cutting down the weight of the missile guidance system, and because the ship is in motion we have to, of course, be able to resolve the effect of the ship on the ballistic missile as we do in shipboard gunnery at sea in ships today. In propulsion, of course—there we are completely unique, because of the very nature of the motor. We had to develop not only a high-energy propellant, but also the chambers to hold this, and the thrust vector control which is a means to rudder or guide the missile.

As you know, the liquid fuel missiles swivel the entire engine and thus get their ruddering effect from that. We cannot swivel because it is one solid missile, just as solid as this is [indicating], and you don't very well bend this. So what we do is put ruddering devices, called jetevators, on the ends of the two stages, and we get our thrust vector control. This we did not know how to do. We evolved a method. It is highly satisfactory. Similarly, we had to evolve a means of cutting off the thrust of the motors at the precise timing necessary in order that we would not overshoot or undershoot the target. With this, again, we have had unique success.

Of course, the flight control, flight control by thrust deflection, I will go into a little bit further. Now, in our ground test program, emphasizing, as we have, the efficiency and low cost of doing the majority of our work on the ground, we have conducted many thousands of tests in the various elements of developing and bringing forward a missile. We have, of course, the warhead reentry body. How do you keep it from burning up? We conducted hundreds and hundreds of tests in our various ranges, sled tests, and so forth, simulated equipment structures, to withstand the load. This missile has a very unique requirement on its shell. I would just like to briefly describe the

conditions that the missile sees. It is sitting in this submarine, in its launch tube here [indicating], and at temperature and pressure. All of a sudden it gets a shot of high pressure air at its base, which is a tremendous booster, and as it comes through the water, it gets its face wet, and then it gets into the air, and up here someplace it starts its motors and it dashes off to outer space in a remarkably short length of time.

This kind of environmental change requires that we give unusual attention not only to the strength and shape and form of the ballistic shell and missile, but also to the electronics, the packaging, and so forth.

Mr. MILLER. Then the missile is actually fired from the submarine by compressed air and is free before the engines start?

Admiral RABORN. Yes; it is in the air above the water when the first stage missile is fired.

Mr. MCDONOUGH. Is the depth classified?

Admiral RABORN. Yes, highly classified. One of the problems, of course, is how you separate the first stage from the second stage when it is in the air. You have to do this very cleanly. You don't want to introduce a wobble to the second stage by rough separation problems, and this, too, we completely tested out to our satisfaction before we went into the air. This is a part of the static test. This is the primacord joint here. The interstage loading I talked about, and of course, the second stage, had to be ignited and take off on its path in good fashion. This is a picture of one of our motors being actually static tested on the ground. It shows you some of the flame and fury that evolves around it. This is a picture of vibration tests. Of course, we have many shock and vibration tests which are applied to these missiles, because of the burning of the powder.

Here again, this is a little different from liquid fuels. We get vibration; we get unusual vibrations which are not normal to others. Of course, they have vibrations, but in different frequencies, and they have different effects on the missile.

In general, you might say that the supporting activities for flight test can be graphically illustrated by this Vu-Graph. We have the underwater launch facility off San Clemente, and I will show you a moving picture of this a little later, a most unusual activity. This is the world's first, where we have conducted many underwater launchings of missiles.

Now, when we got into underwater missiles they were lightweight and expensive in construction. So we took this building crane already in existence at the naval yard in San Francisco, and we put an aircraft carrier flight deck arresting gear up here, and attached two cables to it. And when the missile was fired, we caught the missile and suspended it in midair here, thus saving a tremendous amount of money, because the missile itself would have broken up, and also the instrumentation would have been lost. This is a very, very wonderful thing. We have a similar one which is on a couple of barges tied together catamaran fashion, which catches the missile when it comes from the underwater launcher.

Of course, our ship motion simulator, which I am sure most of you have seen at Cape Canaveral, is here [indicating], and we will flight test our missiles from this with something of the roll of the ship, and

also the air eject. This is a service-type launcher. We have one captive test stand, because we do not need more, but we need this one, and we put complete missiles in that, and we have invented a very ingenious way of holding this missile with flexible holddowns, so that it can work in a response to commands given to the rudders (the jetevaters) and we can work out the missile as a whole in limited flight test. It is a flexible flight test arrangement.

Of course, our vibration tests and reliability tests are going on all of the time, as well as our static tests and our separation tests. This is the missile on its side. And we tested, of course, the efficiency of clean separation. This is a picture of an above-the-water launcher, where we have conducted many of our problems. This, of course, is directly related with the problems of bringing forward a successful Polaris missile, and this is peculiar to us and different from all other missile development problems in the United States.

We must be able to eject that missile successfully and the structure of the missile must take it, as well as all the internal parts, and I am glad to say we have the problem well in hand.

This is a picture of the Sky-catch, with the wires down from the arresting gears, and this was fired and caught. It is a very ingenious way. I am proud of our team which evolved this idea at small cost. This is a closeup of the underwater testing of a dummy missile. This is the Fishhook that I told you about. These are two steel barges. And this tall structure—Fishhook—200 feet high above the water, with aircraft arresting gear engines in them, with single wire leading down into the muzzle of the launcher, which is well down below the water, the missile is fired and is caught in the air. This is part of the tests, the peculiar tests, peculiar to Polaris missile development.

Here is the ship motion simulator, a cutaway. The level of the ground is here (indicating), and this large ship motion simulator, which simulates the three motions of the ship which we are primarily interested in, the roll, pitch, and heave, fires the missile and we get good information as to the effect of these motions on the missile itself and its internal parts.

Now, we have a missile test ship, and I apologize that the ship cannot be seen too well. It is here. It is a stern view of the USS *Observation Island*. It is being completely equipped with all of the submarine launching weapons system, and has been working in the Cape Canaveral range. We will actually fire missiles from this ship in the Cape Canaveral range. Here we have just ejected the dummy missile as a test of the missile and the launcher.

Now, going into specifics of the flight tests, I would like to tell you that we have endeavored and have, I think, to a remarkably high degree, effected the greatest economy in our flight test program, which is our limited flight test program. In order that we could prove out these major elements in the air and in the environment in which they have to work, we have evolved a series of test vehicles, flight test vehicles, from standard parts. We didn't have to do any development work. These were off-the-shelf motors, and so——

Mr. ANFUSO. Right there, Mr. Chairman, I would like to ask a question.

The CHAIRMAN. Mr. Anfuso.

Mr. ANFUSO. Admiral, you say on page 4 that you have made 33 flight tests?

Admiral RABORN. Yes, I will come to that in just a minute, sir.

Mr. ANFUSO. When you do come to it, will you tell us whether that is in the Polaris configuration?

Admiral RABORN. Yes, sir, I will be glad to tell you that, sir. In order that we could evaluate the trust termination, develop instrumentation and analysis techniques, we used a very small solid propellant rocket. The motor was off the shelf. Similarly, in evaluating the forward end thrust termination, we built up a slightly larger one and went right on down the line until we finally got into a flight test vehicle which we are now shooting, which resembles the operational Polaris, but it is still—and I would like to repeat this, as I will later—a flight test vehicle. It is not an operational missile. It is a flight test vehicle of medium range, because once we got these problems worked out we wanted to put them together and see how they behaved in the Polaris form.

We are very proud of these results in the 3 years which we have been working on this, that we have designed and tested, ground and flight, and achieved our goal for the first missile: in our propellant, also the directional control, ability to steer the missile, and the light material for the motor cases. All of these are world firsts. Thrust determination is an invention which we brought forward and which has proved eminently successful. Stage separation of the first stage and second stage, had never been done before in such large missiles, and we are quite proud and happy to say that it is very successful.

A very small guidance system, the smallest which has yet been evolved, had a very wonderful test the other day, and I will tell you about it a little later, a small, compact reentry body, also was successfully achieved and tested. We have developed control of an unstable vehicle in flight, we have had several occasions to note with pleasure, although the missile was unstable and we would much rather it had gone straight.

Underwater launch, the world's first, is also well in hand, as well as the missile and launch compatibility. Now, we get into the types and numbers of flight tests. Using those long series of flight test vehicles which I showed you in a previous slide, we have fired 33 of them, and 24 met their test objectives, which was to get information on how well we did, and we demonstrated thrust termination, motor stage separation, flight control components, missile guidance, and reentry body. We had 24 out of 33, which were considered most successful, which is an extremely high order of successes, and one which I, in my own knowledge, would not expect of any test prgram. We had seven which were partially successful, one or more of the prime objectives being met by these tests. We did not get them all. Two were unsuccessful because we achieved no flight test objectives, but we did get darned good information. I will tell you about that later. So we have not had a repetition of these problems, which, of course, is part of the game.

In summary, then, we have had 33 development flight tests; 24 have been fully successful. Seven have been partially successful, and two, while yielding information on the problems for which we got remedies, were considered by official definition as unsuccessful.

Now, I thought you would be interested, Mr. Chairman, in other elements of the system, not including the missile on which I have just reported.

On submarine construction, it has been designed, and the first submarine has been launched. As you know it is the *George Washington*. The submarine weapons system has been designed and we are in the process of testing it, and we will complete its testing in late 1959 and early 1960. Launching and handling has been designed, tested, and achieved; an accurate navigation system, the same; precise fire control systems and command communications, the same. The tender conversion, which is a maintenance tender for the submarines, is currently underway. I saw that last week down at Charleston. They are doing a good job down there. Operating crews are under training, and we expect to have the crews ready to go aboard when the ships are ready to take them.

Naval weapons annex, which we are in the process of constructing, I saw that last week, too, and I am glad to say we will have that ready to bring the missile and warhead together, to put it in the submarine by the time the submarine is ready to take it.

The work we have yet to do: As you know, we will be operational toward the end of 1960, calendar year 1960. This is a goal which has been twice accelerated. We started out to bring this system into being in 1965. At specific requests of the Government, we accelerated it to 1963, and then last year we were asked to see the very best possible we could do, and we said we will knock our brains out, if you please, to give it to you in 1960, and that is exactly what we are doing.

I am happy to say I have every confidence we are going to do it. But we have yet to test out and validate the operational sequence, working out all of the gear, and obviously that will wait until we get the submarine completely equipped. The operational missile, we hope to prove out in the remainder of the over-a-year period which we have to conduct our flight test and work out the remaining problems. Ship motion simulator, we will achieve this year. Surface ship live firings, we will achieve this year, and submarine live firings, when the *George Washington* becomes operational next year we will shoot missiles from it. I am happy to say we are on schedule. Pictorially, the things that we have accomplished in flight tests, we have accomplished our first flight test vehicle and fired that in September of last year on a schedule which we published over 2½ years ago. This, to my knowledge, is the first time in a missile program, in the history of our country, that a published program 2½ years before was met on a first full-scale test vehicle flight. I think this is a distinct credit to Lockheed and combined Lockheed and naval team that brought this flight test into being.

From the *Peashooter*, the first surface launcher testing was done in 1957, from the *Popup* the first underwater launch was done in 1958, and we fired our first large-scale flight test vehicle, as I said before, from land in 1958. Our ship motion simulator development has been brought along and also our missile firing ship is in commission. It was commissioned December 5 of last year, and we will fire our first test vehicle from it this year.

The first guided flight will be done from the land, and our first missile will be launched from a submarine in 1960. I have a rather interesting movie of a typical flight test. I say it is typical because——

Mr. ANFUSO. In other words, Mr. Chairman, the Polaris will become operational in 1960?

Admiral RABORN. Yes, sir, the whole system.

Mr. ANFUSO. About what time?

Admiral RABORN. The last part. I think it has been said by Mr. McElroy in the fall of 1960.

The CHAIRMAN. Now, you just said you would have a launching from a surface vessel within the near future?

Admiral RABORN. Yes, sir, this year.

The CHAIRMAN. How close will that be? Is there any target date you can give?

Admiral RABORN. It will be the last part of this year, within the next couple of months, we anticipate.

The CHAIRMAN. Within 60 days?

Admiral RABORN. Yes, sir, we hope to have it.

Mr. MCDONOUGH. Admiral, do we have any knowledge of any similar operation by the Russians?

Admiral RABORN. There is certain information which has been published in the papers. Because of the classified nature of that, sir, I would like to refrain from answering in open session.

Mr. MCDONOUGH. Well, then, do you think we are ahead in this particular field?

Admiral RABORN. I can say, in an unclassified open session, that we believe we are considerably ahead of anyone else in the world.

The CHAIRMAN. Now, Admiral, does that constitute your full statement?

Admiral RABORN. No, sir, I have a short movie. It is the last flight test of the Polaris-type flight test vehicle, and I would like to show you the nature of the flight, and I will narrate it, if I may, to show you what we have learned from it.

The CHAIRMAN. Let's do that while we have such good attendance.

Mr. ANFUSO. Before that, Mr. Chairman, could I ask a question following up Mr. McDonough's question, as to whether or not we are ahead of——

The CHAIRMAN. I believe everybody is going to want to ask questions. Can't you wait until right after this?

Admiral RABORN. Mr. Chairman——

The CHAIRMAN. Go right ahead.

Admiral RABORN. I have a 1-minute flight test I would particularly like to show.

The CHAIRMAN. Go right ahead and show your flight test.

Admiral RABORN. Following that I have a 15-minute—or I think it is about a 12-minute movie showing several of the flight tests which I have described. I thought perhaps it might be of interest to the committee, and I will be pleased to show that.

The CHAIRMAN. Sure. Show us a few successful tests you made.

Admiral RABORN. Well, they are not all successful, far from it. Now this is a picture of the flight test of the Polaris medium test range vehicle, which we fired on the 15th of July, this month. Here it is on

takeoff. This is very slow motion camera work, and so the missile is moving quite slowly. In reality, because it is a solid propellant missile, it takes off quite rapidly, much more rapidly than its liquid fuel cousins. The missile has pitched over and is headed out to sea.

Now, on takeoff, one of the jetevators, we have four of them as you know, unfortunately broke, and half of it fell off on the pad. Even though it had three rudders instead of four, the missile performed quite well, until it got up some thousands of feet in the air, when a strong wind current hit the missile, causing the control rudders to work harder, and because it didn't have one of them the missile started to roll and then it started to do what amounted to, in my parlance, an outside loop.

Now, while this is something which is the first time it has happened in over 200 tests; that is, the jetevator cracking and falling off, nevertheless we have shipped that out and have completed a very detailed intensive metallurgical examination of it, leading to test methods of discovering them in the future. Now, the missile is out there 8 or 10 miles off the cape and has started its outside loop. You will notice the structure of the missile is such that it does not come apart and it will compete its outside loop in a minute and come back up and separate the first stage from the second stage, which is a part of the normal function.

Now, some of the cheering things about this is that the missile separated properly even under the most unusual attitude and conditions, giving us great confidence in this separation procedure.

Now, at about here you will see the first stage separate. In other words, the ability of the missile to go through unusual conditions in the atmosphere and the water is quite well shown in the structural strength of the shell. There is the first stage separation. The second stage then heads off, and in a few minutes the range safety officer—this is going downrange—the range safety officer decided he had had enough of this and so he exploded the second stage of this missile, although it was going in the right direction and behaving quite well. All of this took place quite rapidly, and so it was sort of a delayed reaction in pushing the button to see it destroyed. But you will see it destroyed.

Mr. McDonough. How far away from launching is that?

Admiral Raborn. About 8 or 10 miles off the beach.

Now, you will see it blown up in a minute. It is headed out very nicely, downrange, but all of this happened very quickly, and the range safety officer, when he saw the gyrations, pushed the button.

Now while the next one is being threaded, let me please explain to you about this test. After this test, Mr. Chairman, I had two groups of people in my office. One with faces long like this, those were the propulsion boys, the motor boys, shaking their heads, saying the first time in over 200 tests this has to happen to us. But I had another group of people standing over here who looked like they had just been left a million dollars or so. They were the happiest boys I had ever seen. They were the missile brain boys. This was a test of the missile brain, and in spite of the unusual gyrations which you saw, the missile brain behaved beautifully, they didn't go to pot, and when that second stage flew down range, the missile brain was working perfectly. The missile brain was riding as a passenger, but the success of this, of the

missile brain in behaving under these most unusual test conditions, has caused me to have such great confidence in it that I am now planning to accelerate my program. So here is a concrete example of a flight test which, to a casual observer, was not successful, but from a developer's point of view was highly successful.

We learned two things. We have got to be more careful in examining these jetevators, although we gave them a deep die test, and other tests. But I have confidence that I can accelerate the program of the fully guided shot.

Now I have a short movie which I will try to narrate when you are ready. It will put into more visual form the things which I have talked about, the types of air testing.

Mr. FULTON. Admiral, will the submarine have the power to destroy its own missiles?

Admiral RABORN. No, sir.

Mr. FULTON. Once it is gone, it is gone?

Admiral RABORN. It will be where we hope it won't hurt anything.

Mr. MCDONOUGH. You don't have to operate with a land control station?

Admiral RABORN. No, sir. Well, we will on our test procedures and checkouts, naturally, because we will get more information. Operationally it will not. Now this foreword here just shows a submarine operating in its underwater element. This could be a classified movie, and part of this I will have to omit, obviously, in open session.

This shows you the operational sequence of the missile, ejected by aid, through the water it comes, and takes off in a powered flight once it is in the air. This is the actual flight test vehicle of one of our earlier versions. It is a large solid propellant missile, even larger than our Polaris test vehicle that we are using today. This, of course, is the submarine. I show you this because I want you to see something of the environment in which we have to operate. We have some most unusual motions. This is our missile manufacturing center out at Sunnyvale, where we do the development work and will do the production of the missile. It is a Navy-owned building, naval ordnance reserve plant. This is a showing of a scene at Cape Canaveral with one of our large flight test vehicles on the truck there going out to the launch pad from the hangar.

As I mentioned before, we use many and varied kinds of flight test vehicles, many of considerably smaller shape and configuration than the present vehicle, to prove out many points we had to prove by flight tests.

This is one of our early separation tests. Until recently, this was the largest solid propellant motor ever fired in this country that we know of.

Mr. MILLER. Where was that?

Admiral RABORN. Aerojet-General Corp., Sacramento, Calif. This is a very large powerful motor. From this grew the techniques which we are looking for. Here is a a ground test which shows the thrust termination, ability to cut the thrust of a solid propellant motor off. The liquid fuel motor, you just cut off the gas and it stops, but not with a solid propellant. We had to evolve some rather unique ways.

This shows some of the early test equipment for our fire-control system. We conducted many, many ground tests as to the shape and form of our reentry body and, of course, the missile as a whole, the staging, the separation problems, the entire staging, how do you tie the two together without making it too heavy. This is one of the early flight test vehicles, the purpose of which was to prove out some of the flight test characteristics. They were built up by on-the-shelf standard parts, and thus we kept the price of our development program down to a very conservative level. This is a full-scale mockup of the missile shown here, and the man alongside it gives you the relative size. It is a very small, compact missile. We have worked out all of the problems that we could anticipate, inspection and maintenance by means of such a mockup, and this, of course, is done with all missiles.

This is an actual flight test vehicle being prepared, with special instrumentation being installed. This is one of the reasons why it takes so long to prepare a flight test vehicle, the installation and checkout of the many, many test equipments which must go in if you are to get the information which you are seeking as a result of the flight test.

This is a separation test shown here. This is the first stage and the second stage mocked up, and internal primacord. It gave a very clean separation. This is the way we tested it on the ground before we put it in the air.

This is one of the shock tests of the missile components, in order that it might take the flight environment. This is a shake test. This is a full-scale separation of the first stage and second stage motor, showing the ignition of the second stage. These things we did our best to prove out on the ground before we got into the air. This, of course, is a good test of the nozzles and jetevators, and also, many problems which we have worked out for this kind of testing. These are the several kinds of flight test vehicles which we used before we got into the present full-scale, operational-type missile. While some of these missiles looked small and insignificant, they yielded a tremendous amount of information, and they enabled us in the 3 years we have been on this program to have consistently met our development milestones, and for this, of course, I give highest honors to our wonderful dedicated development team. These are some of our small flight test vehicles. This happens to be a thrust termination. We track it with these radars and other antennas to get the telemetry which is being transmitted back. This is in free flight. Here is another small-flight test vehicle. This is the Lockheed-developed X–17, developed under contract to the Air Force. It was a perfect flight test vehicle for us to use in our reentry body work, and we were very grateful the Air Force had previously paid for the development. We, being a poor service, are very happy about getting this.

Now this is a flight test vehicle which is built up. You will notice the base here is the same size of the Polaris present-day test vehicle, and so we were able to test the jetevators on that. This shows—this is the full scale down here, the rest isn't but this is actual flight test of something less than a Polaris missile, testing with jetevators. It was highly satisfactory. We had 17 out of 18 of this kind that were highly successful before we got into the present flight test series.

The rapid takeoff of these solid propellant missiles, of course, imposed some special range problems. I am very glad to say that General Yates, at the Atlantic Missile Testing Range, has worked with us and our development team very well, indeed, and together we have been able to work out satisfactory solutions to the different problems which the solid propellant missiles imposes on the range safety element of the Atlantic Missile Range.

This is one of the static tests, our static test stand at Santa Cruz Mountains in California, where we can get limited motion of the missile and determine how well it behaved, even though it did not fly. This shows some of the packaging problems, the shipping problems, of the missile. We had to evolve special containers. These missiles' motors are shipped fully loaded. We have, by series of tests, passed all of the requirements necessary to get this motor classified as a fire hazard and not an explosive hazard. This, of course, allows us to ship it with considerably less restrictions, due to interstate commerce rulings, and the confidence we have in this motor being safe is such that we can say unqualifiedly that the propellants which we use in this Polaris missile are safer than the rockets which are aboard ship today, namely, the rocket motors aboard ship today.

We dropped one from 28,000 feet and it didn't explode. I think that is probably the most severe test you could give.

This completes my presentation, Mr. Chairman, and I am most grateful for the opportunity to assure you that this missile program is on schedule across the board, and we expect fully to have it operational the latter part of the next year.

The CHAIRMAN. We are very happy to have your extended presentation. The committee is fully cognizant of your many problems. I would like to ask a few questions about the Polaris missile.

You say the first real test will be made within 60 days of the completed missile from surface; is that your statement?

Admiral RABORN. No, my statement is we will go to sea in our missile test ship, the *Observation Island*, and within the next few months hope to fire a flight test missile of the kind we are firing from the cape from the *Observation Island*.

The CHAIRMAN. Within 60 days?

Admiral RABORN. Well, that borders on classified information, the 60 days. As I recall, if I may leave it indefinite, it is in that order.

The CHAIRMAN. Well, I am not trying to tie you down.

Admiral RABORN. It is in the very near future, before the end of the year.

The CHAIRMAN. But you do expect that to be out of the scientific stage and into the operational stage in 1960?

Admiral RABORN. Yes, sir; we certainly do.

The CHAIRMAN. Now, the Polaris is an intermediate range missile, isn't it?

Admiral RABORN. It is a 1,500-mile range missile. That is our range objective. Combined with the new submarines, we take it closer and hit the longer-range targets.

The CHAIRMAN. What would the altitude be that the missile would make, would you say?

Admiral RABORN. It is no secret that anything that can go 1,500 miles in free flight must go 400 miles high. That is no secret.

The CHAIRMAN. It is a space weapon, then; there is no doubt about that?

Admiral RABORN. Yes, sir.

The CHAIRMAN. I have been reading this morning that some commentator, who seemed to have a grasp of this subject, felt like the percentage of accuracy in the tests should be rather high before a missile should be operational; for instance, the Redstone. I think that he established a percentage of 98 percent successes in the launching. Would you say that 98 percent correct would be a fair test to set for Polaris?

Admiral RABORN. I would say that such percentages of reliability as to hitting the target have to be, of course—you have to look past the missile into the rest of the system. To be able to hit the target 98 percent of the time is indeed a very admirable objective.

The CHAIRMAN. Well, I think that is the claim of Redstone; that out of 50 firings, 49 were successful. Of course, that is just a 200-mile-range missile.

Admiral RABORN. Yes, of course, that is very fine performance, one we would all like to emulate.

The CHAIRMAN. Can we set something in advance as to what percentage of reliability you should demand of it in order to consider it successful?

Admiral RABORN. Well, sir, this is something which has to be carefully fitted to the individual weapons system, and it is different for different weapons systems, and we are shooting for as high a reliability as is possible in human ingenuity to obtain. Just what we are going to get by the end of 1960, calendar year 1960, I am not sure, but it will be as high as it is possible to obtain.

The CHAIRMAN. And you will not set your standard of requirements as to reliability until after you see what you can do?

Admiral RABORN. We have some very high standards in the Navy, sir, in safety, because we are aboard ship. We set safety of a weapons system to be paramount. It must be safe. We should not endanger the rest of the ship. We will set that up first. The reliability, efficiency, effectiveness of the system as a whole is set also equally high, but below the requirements for safety.

Now, the requirements for safety, of course, as I said, are paramount, but we have consistently held the view that our weapons system should be as effective and reliable as it is possible to make it.

The CHAIRMAN. This writer also said with reference to one of the ballistic missiles, that it had about 300,000 different parts. Is that correct?

Admiral RABORN. It could be for some ballistic missiles. Fortunately, although we don't want to underestimate the complexity of any missile, fortunately the solid propellant missile which we are building is considerably less complicated, by the very nature of its motor, than other types of missiles.

The CHAIRMAN. So it will have fewer than 300,000 parts?

Admiral RABORN. Considerably fewer.

The CHAIRMAN. Now, is it the small parts that are giving you trouble in the development, or are there major features of the missile that are giving you trouble?

Admiral RABORN. It is the small parts. We have had our difficulties, of course, in bringing forward the development items, the major items of which I spoke, of the control of the missile. How do you do it? How do you terminate the thrust?

Those are major development milestones. We have most successfully accomplished those on our prearranged and preprescribed schedule. Obviously, in putting something together for the first time and shooting it for the first time over a series of developmental tests, we have to put aboard considerable amounts, as I mentioned before, of instrumentation. All of these add to the complexity of the missile, and a missile, as General Yates so very well said on a TV show which I was privileged to see—someone said "Well, is a missile ever a failure?"

He said "Yes."

They said "Describe one."

He said, "A missile which takes off from the cape in developmental flight, it flies beautifully, all of the telemetry is lost, and you get no data from it." That, in his opinion, was a failure.

The CHAIRMAN. A successful flight, then, is one from which you can get data to use for the future?

Admiral RABORN. Yes; to confirm or approve.

The CHAIRMAN. Now, this writer said that one of our major problems was propulsion; is that correct? And he said the other was guidance.

Admiral RABORN. Those are the two general areas you have to contend with, depending on how far you want to go.

The CHAIRMAN. On the propulsion, using the solid propellant, you are satisfied with the performance of the propellant itself, are you not?

Admiral RABORN. For our first model; yes, sir.

The CHAIRMAN. And so your problem wouldn't be there, but it would be in the use of that propellant in your missile?

Admiral RABORN. Well, we have satisfactorily proven to ourselves by these tests that we can use this propellant for the first operational missile. We are in a position now of completing our component tests, putting them all together in an operational type missile, flight test vehicle; in other words, a more advanced one, and in the next year or so we will complete this process and actually get into the last stages of full operational flight test missiles.

The CHAIRMAN. Now, what about the guidance system; is your guidance system in Polaris similar to the guidance system of some of these other missiles?

Admiral RABORN. The philosophy under which the Polaris missile guidance system is designed is quite similar to that of the Thor. As a matter of fact, the reason for this undoubtedly is because it had the same daddy, which is Dr. Draper, Charles S. Draper, head of the instrumentation laboratory of MIT. We do, however, use considerably smaller components, accelerometers and gyros, because we have had to compress it and get a very smaller weight-size guidance package, because we have a very much smaller missile.

The CHAIRMAN. Now, if you were to ascribe some reason for your failures—and I notice you have your failures down here to two, and partial failures to seven—what would you say would be the major reason that seems to run through this program of testing this missile?

Admiral RABORN. There are failures—let me describe the first one, the first failure. There was a missile sitting on its stand ready to fire. We fired it, and to our utter amazement the first stage motor just sat there and burned up on the stand. The second stage motor, because the first stage motor blew its stack, so to speak, or its top, was ignited by the hot gasses that were exposed to its nozzles, sitting right on top of it, and it took off like a scared jackrabbit and had to be cut down by a very alert range safety officer. What happened was this: On the top of the first stage motor and on the second stage motor we have a large filler hole we put the propellant in. It is about that big around [indicating]. We have a plate over it, over that filler hole, and that is held together by a clamp. Now, we have explosive bolts, three explosive bolts, in these clamps. Those explosive bolts are put there as a test device in order that the range safety officer, should he have need to, can explode the missile. In other words, he can blow it apart. We do not have those explosive bolts in an operational missile. We have a solid clamp.

What happened was, when the first stage motor was ignited, of course, the pressure built up, and through a quirk which we had not previously been able to detect in very thorough testing, one of those explosive bolts was crimped, and it exploded itself, blew open the top of the motor, which ignited the second stage, and it took off the way that I previously described.

Now, this is a test device because, in my opinion, it was a failure, but we have remedied it and we have had no repetition of that.

The CHAIRMAN. What was the next one?

Admiral RABORN. The other one had to do with a little electrical motor which we call a programer. When the missile takes off, the programer tells the missile to arc out to sea, if you please. Now, although this programer is being used by all missiles of similar types in the whole national effort—and we have had many, many tests of this—suddenly on this particular instance it decided not to function. In other words, it was not activated, although it had previously been checked out before firing and had functioned all right, we pressed the firing circuit and apparently the electrical current didn't get to it.

So the missile, having received only one signal to fly straight up as it came off the pad, continued to do so. Here again, a test device caused the motor not to arc out to sea, and the range officer very properly pushed the destruction button and we got little or no information.

However, we said to ourselves, "Well, we will fix his wagon and"—I am talking about the programer now—so the programer was put behind the first stage ignition circuit so that the first stage motor could not be ignited until the little programer was running, so that it had to function before the missile was fired. So here again we learned something, but the test device caused it to be a failure.

The CHAIRMAN. You corrected that situation?

Admiral RABORN. Yes, and we have had no repetition.

The CHAIRMAN. Is there any theme running through your seven partial failures?

Admiral RABORN. No, sir. We had two flights on which we had trouble with the jetevator sticking in the air. Now, apparently there were some difficulties when the missile goes transonic, it goes

supersonic and the flow of gas out of the nozzles was diverted a bit, depositing metal particles around the jetevators, causing them to bind. So what we did then, we had two of these happen that gave us difficulty on certain performance out there in flight control. We took the seals out, put a little baffle behind them, and we have had no further trouble.

Now, we had two others of these partial successes which had rear end heating—the end of the motor heated up. This was also caused by the diversification of the smooth flow of air down the side of the missile when it went transonic, causing the rear end to get an unusual shot of heat. And so what we have done there is to get some very lightweight insulation and put over the end of this, and we have had no further trouble. That is the nature of the partial failures.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. No questions.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. How many submarines of this Polaris type are programed now for the United States?

Admiral RABORN. We have nine approved and under actual construction, sir. We have long leadtime for three additional submarines in the 1961 budget.

Mr. FULTON. How many were requested by the Department as being necessary for our security; how many did you originally request; and how many were given of that request?

Admiral RABORN. The Department of Defense requested this number and received that number.

Mr. FULTON. So there is no difference between the number the Department feels are necessary for U.S. defense and the number that you have under construction?

Admiral RABORN. That is correct.

Mr. FULTON. How many of these missiles are carried per submarine? I see you have a certain number on this model.

Admiral RABORN. Yes, sir. There are 16 missiles per submarine.

Mr. FULTON. How long is the life of the missile? How long can you have the fuels put in the engine and then held in the container? How long will the firecracker last?

Admiral RABORN. We are conducting aging tests on our propellant. The nature and characteristics of this propellant are considerably better than that which we have experienced in the past, and normally a solid propellant motor has been thought usable somewhere between 3 and 5 years, depending upon the specific nature.

Now, this leads us to think that perhaps these motors would be most usable up to 5 years.

Mr. FULTON. So there is no limitation on the life of the missile as to the length of time the submarine can be operational?

Admiral RABORN. That is correct.

Mr. FULTON. Then with 70 percent of the world's surface composed of water, and with a 1,500-mile range, approximately what percentage of the world's strategic areas can this missile cover? I would think it would be some very high amount, wouldn't it, because with 1,500 miles on either side you could obviously cover the whole North American Continent and South America, as well.

Admiral RABORN. That is correct. We have, of course, studied this problem and the general conclusions of our studies are with a 1,500-mile missile, in a ship that can move around and approach the coast, there are no significant military targets that we know of that could not be brought under or threatened with this type of weapons.

Mr. FULTON. And likewise, large nuclear or manufacturing targets could all be brought within the range of this weapon?

Admiral RABORN. Yes, and without doing a thing to the submarine, we believe we can improve the range of the missile. This is the history of all weapons systems, they are improved in performance as we go along.

Mr. FULTON. Now, this missile can be used on surface ships or stationary rafts, as well as submarines?

Admiral RABORN. That is quite feasible; yes.

Mr. FULTON. The advantage of the Polaris is that the base is maneuverable, and therefore it cannot be quickly counterattacked?

Admiral RABORN. We feel that the mobility and concealment which is inherent in a submarine or on a surface vessel, do not make them targets for ballistic missiles, cannot be successfully attacked by ballistic missiles, and we feel that they make them—give them one of the major elements of any good major war deterrent, and that is the fact that it cannot be zeroed in ahead of time and marked for quick destruction. It is going to be there when you want to use it, and that is one of the fine virtues of this system.

Mr. FULTON. Now, on discovery, once the shot is made, of course, there is going to be an ionized trail left when the missile gets going under its own power, as distinguished from compressed air. What of that? Is there a great possibility of detection, Admiral?

Admiral HAYWARD. Well, Mr. Fulton, once you shoot the missiles, with the reaction time you have with the solid propellant, the missiles will be shot. If you lose the submarine, that is part of the deterrent system. We hope, of course, that it is never used. If it is used, the deterrents have failed, obviously; and in regard to the mobility, we in the Navy—as you know, Horace Greeley said "Go west"—in the deterrent business we say "Go to sea, get mobility and concealment."

Mr. FULTON. Then there is the question of your target error, the CEP, circle of probable error. Are you able to say just how big an error that would be?

Admiral RABORN. Not in an open session.

Mr. FULTON. One of the officers said you could hit the ballpark but aren't able to put it in the reserved seats.

Admiral RABORN. We expect to hit the ballpark.

Admiral HAYWARD. Everybody knows the inertial physical principle of the Schuler pendulum. You can figure it out. This is the component work. Of course, when the CEP's come down, it makes the fixed systems even worse.

Mr. FULTON. One other thing. You had shown in development certain sizes. Actually, you have never changed from your conception as to target size?

Admiral RABORN. We developed these goals 3 years ago and we have found they were very good goals to shoot for.

Mr. FULTON. What is the operational cost per missile in dollars? What is your estimated cost apiece when you get these operational?

Admiral HAYWARD. Do you amortize it over the life of the vessel? This is an awfully difficult question, Mr. Fulton, the actual cost of the operational missile on target. You can get any figure you really want. The life of the submarine is 15 years.

Mr. FULTON. Terriers cost about $40,000 apiece, installed. What would these cost?

Admiral RABORN. We expect the operational missile to run about $1.2 million apiece, less warhead.

The CHAIRMAN. That would depend on whether you charge all of this scientific investigation to the individual missile or whether you cut it off and just simply charge the construction after it is perfected?

Admiral RABORN. That is correct. We get any number of figures. I am very glad to say that we have been required by the Navy to budget for everything that goes into this whole weapons system. It is my responsibility to handle the funds for everything from construction of that submarine, development of the missile, selection and training of the personnel, all of the test work, and we do have for the first time, I believe, certainly in the Navy, good estimates of what it takes to bring a system into being and what it costs to operate it.

Mr. FULTON. Of course, on a missile of this size somebody could calculate very readily what your kiloton capacity is. Is that public?

Admiral RABORN. No, sir.

Admiral HAYWARD. Do you mean kilotons in payload, Mr. Fulton?

Mr. FULTON. Yes. That isn't public?

Admiral RABORN. No, sir.

Mr. FULTON. I want to congratulate you and say that we are very proud of the Navy and its program and the results that you have, and say to you that I think this is one of the best missiles we in the United States have, because of its concealability and maneuverability.

Admiral RABORN. Thank you, Mr. Fulton.

The CHAIRMAN. Mr. Miller.

Mr. MILLER. I have no questions, but I do want to compliment you, Admiral, on part of your statement. You showed you were introducing some of the "soft" sciences into the work of training your crews. This is a little different from the "soft" sciences in the Navy, which used to be a cat-o'-nine-tails, so we are making progress in that direction, which I think is just as important as some of the hard sciences in these fields, and I want to congratulate you upon that.

Admiral RABORN. Thank you, Mr. Miller.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. I just want to compliment the Admiral on the very clear understandable exposition and revelations he has given us this morning in the operation of the missile. I think he has done a remarkably fine job. I am very hapy to hear that your schedule is ahead of our potential enemy.

Admiral RABORN. Thank you, sir.

The CHAIRMAN. Admiral, you seem to be very popular in these parts.

Mr. Teague.

Mr. TEAGUE. No questions, Mr. Chairman.

He might tell me where he is from.

Mr. DADDARIO. No questions, Mr. Chairman.

The CHAIRMAN. Mr. Anfuso.

Mr. ANFUSO. Mr. Chairman, I have a few questions to ask, and I, too, want to congratulate the Navy in this particular enterprise. I, think, Admiral, that all of you men seated there have developed something which could change this whole method of waging war—and let's admit the fact that we are at war. A lot of people seem to think that we are not, but Russia is certainly at war with us. I think that you have developed something which could change our entire method of warfare and give us an advantage.

We all know that the ICBM sites can be wiped out by the enemy. If they know where one is all they have to do is aim for it and they can wipe it out. That cannot be done with these submarines, because they have to be pinpointed, and it is very difficult to pinpoint them. So the possibility of destroying them is not very good.

Now, if, Admiral, we are to narrow the missile gap and gain this advantage that I am speaking of, then in view of the present slow development of our ICBM, would it not be practical to install Polaris missiles on surface ships, such as cruisers?

Admiral RABORN. We have conducted studies on this, as you would expect, to explore possible exploitation of the weapons. We have found that the system which we will put aboard submarines is quite adaptable for cruisers.

Mr. ANFUSO. Thank you. Now, wouldn't such missiles in effect become ICBM's by having the capability to strike almost all of the same targets as ICBM's, which you say can go 1,200 to 1,500 miles, that the United States could strike?

Admiral RABORN. They could be ICBM's in range. The ICBM's we are constructing, of course, carry a larger payload, but from the range standpoint they certainly could be classed in an ICBM category.

Mr. ANFUSO. And isn't it a fact also that Polaris missiles installed on surface ships would be more truly mobile, less vulnerable, and therefore more effective even than the Minuteman missiles installed on railway cars proposed for the sake of obtaining mobility?

Admiral RABORN. We are understandably proud of the many advantages of this system, sir, and I think that, with due deference to our sister service and their missile programs, that we would agree to that.

Mr. ANFUSO. Wouldn't the further development of this program do this: It seems to me that the Polaris missiles aboard cruisers or other surface ships would complicate the defense picture of the enemy.

Admiral RABORN. We believe that the mobility by putting the missiles on ships at sea would greatly complicate the defensive measures which any potential enemy might take to counter them.

Mr. ANFUSO. Wouldn't the enemy have to change his defense plans to a considerable degree to take on this account?

Admiral RABORN. We believe that is so. The fact that you cannot zero in an appropriate number of weapons to knock out a fixed position, because these would be under the sea or on the surface of the sea and moving around, certainly would cause the enemy to take another look, if you please, should he ever get to the position where he would have enough ICBM's or other weapons which he might calculate he could knock out in a swift surprise blow. This is one of the inherently tremendously fine advantages of mobility of ships at sea.

Mr. ANFUSO. In other words, instead of following the Russians, we could by this process take the lead and have them chase us around for a while and wrestle with developing new modes of waging warfare, which could eventually bankrupt them. They are trying to bankrupt the so-called capitalistic countries.

Now, if we give them a little run-around they will have to develop constantly new methods in trying to catch up to us. Isn't that right?

Admiral RABORN. I believe that this certainly is so, and this weapons system, when we finally get it, is going to prove to be one of the most attractive major war deterrent weapons systems which we will have in our national bag of tricks. Now, I would like to emphasize the word "deterrent," because if the deterent fails, as Admiral Hayward mentioned a few minutes ago, the primary purpose of these weapons has failed, too. No one wants an all-out war, and if we can increase the psychological effect of deterrents so that the enemy will never start a war, a major war, it then is a most successful system, and this is one of the principal potentials of the Polaris in ships at sea, that it does away with anyone getting so assured that they can start a war and knock out his potential enemy without being harmed.

Mr. ANFUSO. Automatically, Admiral, the installation of these missiles on cruisers and submarines would at once make these vehicles, these ships, suspect; isn't that right?

Admiral RABORN. Yes; that is right.

Mr. ANFUSO. Because the enemy would have to again develop a method of attacking them?

Admiral RABORN. Every submarine at sea becomes a potential Polaris carrier, until it is proved otherwise, and we all know how difficult it is to identify the type of submarine or even find a submarine at sea.

The CHAIRMAN. Mr. Anfuso, may I interrupt you just a moment? We have scheduled this morning Dr. James W. McRae, vice president of the American Telephone & Telegraph Co., and member of the Defense Ballistic Missiles Scientific Advisory Committee. Now, we are not going to have time to hear him this morning, and I am wondering if the Doctor would be able to return here. We have two bills scheduled for tomorrow, and I wouldn't want the Doctor to go through the same waiting period tomorrow. I am wondering if it wouldn't be all right sometime next week to call him as a witness.

Dr. MCRAE. Mr. Chairman, it occurs to me that perhaps my contribution to this hearing can be quite brief and could consist of any questions that you care to direct to me, since you have the statement.

The CHAIRMAN. Normally I would say yes; that would be fine, but I do know that we are going to have two votes on the floor of the House just after they convene, and so whether or not we would be even be permitted to stay for questions I can't say. If you want to take the chance, we will be happy to work it that way.

Dr. MCRAE. I would be delighted to do that, sir.

Mr. ANFUSO. Mr. Chairman, I have just two short questions and then I am finished.

Now, Admiral, would the installation of Polaris in a cruiser, for example, interfere with its basic mission?

Admiral RABORN. Certainly not, sir.

Mr. ANFUSO. Regulus II, which was canceled because of the development of Polaris, was planned for certain cruiser installations. Would there be any particular construction difficulties in these cruisers now being built or converted which were originally scheduled for Regulus II?

Admiral RABORN. The space and weight requirements for Regulus, of course, would be available to be utilized by the Polaris weapons system installation. Our requirements of launch tubes, and so forth, are quite different from that, of course, for the Regulus, but our studies have indicated that they can be placed aboard these cruisers on a normal conversion or new construction with a minimum of ship construction difficulties.

Mr. ANFUSO. Now, finally, Admiral, I think you said before that there was perfect coordination between the Navy and the other agencies—the Army and the Air Force and NASA; is that correct?

Admiral RABORN. Yes, sir, we are very pleased with the interchange and spirit of cooperation. I have an Air Force major on my staff, and I have a commander on the Air Force Ballistic Missile Division in Inglewood, and similarly in Army participation.

Mr. ANFUSO. Do you ever discuss special projects? For example, do you ever get together and say, for instance, the Polaris is the best thing that this country can put out, and let's all get together on something similar to this and maybe not go so far ahead with the other programs?

Admiral RABORN. I haven't been able to get my sales talk up to that high level yet, sir.

Mr. ANFUSO. OK. Thank you.

Admiral HAYWARD. He does pretty well.

The CHAIRMAN. Mr. Wolf.

Mr. WOLF. Of either admiral may I ask if this Polaris missile launching submarine has a capability of being used as an antimissile missile launcher, or can the Polaris, or a modification of the Polaris, be used as an antimissile missile?

Admiral HAYWARD. Well, let me say we are looking at the problem. It is only in the study phase. The ASW problem, as this system succeeds, we have the problem in our country that Mr. Anfuso says the Russians will have, we have to be able to defend against the Russian system. We don't have any solution to it now. We are not going to be able to just say that we sighted the submarine or we sank it after the missiles have left. We have to see if we can do something about it. We have no solution to it.

The ideal combination in a ballistic missile would be if you could use it for both defensive and offensive purposes, but this is purely a dream. We have no answer as of now, but we are looking at the problem.

Mr. WOLF. The thing that develops the question is the Bomarc program which has been so extensively discussed. I am wondering again when they are operational they are still out in the open, they have to be exposed, and this would give you the same thing in an antimissile missile.

Admiral RABORN. Perhaps just a statement on this, sir, without getting into classified matters. Some of our studies clearly show that

an antimissile missile certainly has a lot of earmarks of the solid propellant Polaris.

Admiral HAYWARD. We feel there are definite hopes in it, but I would not say publicly that we have any system. We are just studying the problem, looking at it, and if we can do it, we will certainly do it.

Mr. WOLF. Looking at the whole picture now, Admiral, and not just in the narrow field of the Navy, but rather looking at the whole national defense picture, are you satisfied with the amount of money that you have to work with on this program? Do you think you are getting your share of funds in relation to the capability of this weapon? Now, there is a nice, loaded question for you.

Admiral RABORN. I would like to answer it this way, sir: I believe if I did say I was satisfied, I would be the first man who had responsibility for a large development program who would make that admission. In other words, what I am saying is that when you have a tremendous responsibility, you invariably want to protect your ability to do that job to the maximum. However, we have to recognize—and I certainly do—that the Navy has many other problems which they have to fund for, besides the Polaris program. And because of this I can say categorically for the job which I have been given to do and the numbers that I have been given to do and the time schedule that I have to do it, that my program is adequately funded. It is a close, conservative budget, but that is the way I want to play it. I don't want to tie up a lot of dough that the rest of the Navy needs.

The CHAIRMAN. Mr. Van Pelt.

Mr. VAN PELT. No questions.

The CHAIRMAN. Mr. Moeller.

Mr. MOELLER. No questions.

The CHAIRMAN. Mr. Daddario, I think I have called on you.

Mr. Chenoweth.

Mr. CHENOWETH. I just wanted to congratulate you, Admiral, on a splendid presentation. Just one question which you perhaps don't want to answer in open session: a comparison of our submarine program with Russia's. Maybe you have touched on that previously.

Admiral HAYWARD. We have touched upon it with the Congress, but not in open session. We would be delighted to give the committee, Mr. Chairman, this information in closed session.

The CHAIRMAN. At a later date we may have an executive session.

Mr. Bass.

Mr. BASS. No questions.

The CHAIRMAN. Mr. Riehlman.

Mr. RIEHLMAN. No questions, Mr. Chairman.

The CHAIRMAN. Admiral, we want to thank you for coming here, and Admiral Hayward and the rest of your staff. I think the committee has already expressed themselves fully on how they feel about the Navy and their program. We are happy to have you.

Admiral RABORN. Thank you, sir, I appreciate this opportunity, knowing your great interest in the program, to be here.

The CHAIRMAN. It certainly helps us here on the Hill.

Admiral RABORN. I would like to introduce the man directly responsible for the Polaris program in our shop, a fine scientist in uniform, Comdr. R. O. Middleton.

The CHAIRMAN. I want the record to show that he is here and his background and record in the Navy and his contribution to this country.

Mr. FULTON. May I join in complimenting the gentleman.

The CHAIRMAN. Now, if we can quickly get settled here, we will have Dr. McRae and propound the questions we have of the Doctor, and then finish, perhaps, before the bell.

Doctor, we are sorry to have kept you waiting so long, but we will proceed quickly to ask you some questions. Would you state for background in the record some of your experience and training and service with the United States?

STATEMENT OF DR. JAMES W. McRAE, VICE PRESIDENT, AMERICAN TELEPHONE & TELEGRAPH CO., AND MEMBER, DEPARTMENT OF DEFENSE BALLISTIC MISSILES SCIENTIFIC ADVISORY COMMITTEE

Dr. McRAE. This is in the biographical material which I submitted. You would like me to repeat that briefly, I take it?

The CHAIRMAN. Yes, briefly.

Dr. McRAE. I got a Ph.D. in electrical engineering at Cal Tech and then went to work for Bell Telephone Laboratories. I worked for Bell Telephone Laboratories until 1942, when I was volunteered into the Army, and after the war went back to Bell Labs, became a vice president in charge of part of the development activities there, and then became president of Sandia Corp. in Albuquerque, N. Mex., which helps design atomic weapons, and then came back this last year to A.T. & T.

With respect to Government activities, I joined the present committee when it was an Air Force committee headed by John von Neumann, the famous mathematician and scientist of Princeton. This was the committee, as you know, that established the ICBM as a key program and put it in high gear. I joined the committee in 1955, about a year or two after they had gotten started in 1955. Then this committee was changed to a DOD committee.

The CHAIRMAN. Now, as a member of the original committee that established the status of the ICBM as a needed weapon and vehicle, what would you say, in reference to the Atlas program, the ICBM, and especially the recent failures that we have experienced?

Dr. McRAE. I probably look at the failures in ways more nearly like Admiral Raborn does than perhaps you folks did before you heard the testimony. My own opinion is that the program on all of the missiles, the ICBM's and IRBM's, has gone amazingly well and much better than we thought it would go when we originally recommended high priority action.

The CHAIRMAN. Do you think these failures that you have read about in the press and also heard about officially set our program back to any extent?

Dr. McRAE. No, sir.

The CHAIRMAN. You think we are right on schedule in spite of that?

Dr. McRAE. You realize, when you state schedules, 4 years ago for a program that would normally take 8 or 10 years to do, you are taking considerable chances, and it is very difficult to be sure whether

the program will be completed this month or next month or the month thereafter.

I think the program is within 3 months, let us say, 3 or 4 months, of the optimistic guesses we made then.

The CHAIRMAN. Now in that connection, have we lost leadership to the Russians, in your judgment? Are the Russians going further ahead of us, or what is the status there, really?

Dr. MCRAE. It is really very difficult to know what the Russians are doing. They are not free with information at all. They don't even conduct tests at places where people can take pictures of them. The net result is one must base the answer to that question on a lot of judgment, and I would guess that they have been having their troubles, too, and that we are just about in the same position. We have not lost ground.

The CHAIRMAN. From what you say, we then have not gained any ground, in spite of our redoubled efforts?

Dr. MCRAE. Oh, no, sir. I meant that we have not lost ground beyond what we expected we would have after we started this expedited program.

The CHAIRMAN. What I refer to is this: We have not gained any on the Russians, either?

Dr. MCRAE. We certainly have gained. We are doing programs here in remarkably short periods of time.

The CHAIRMAN. You think we have gained on the Russians?

Dr. MCRAE. I do.

The CHAIRMAN. For instance, in the development of the booster, you think we have gained on them? They were way ahead of us at one time?

Dr. MCRAE. We have made up some of the difference.

The CHAIRMAN. How much would you say, percentagewise, we have made up?

Mr. MCRAE. It is hard to tell—50 percent, perhaps.

The CHAIRMAN. Now, what about guidance systems? Are our guidance system still superior to the Russian's, as far as you know?

Dr. MCRAE. From my own knowledge, I can't answer that question except to say that our guidance systems have performed better than we expected they would. That is, I am saying that I do not know what the Russian's guidance systems really do.

The CHAIRMAN. In your position here with the Scientific Advisory Committee, do you check into the reasons for the failures in the firing of the missiles and then do you take any action? Or does your committee take any action in trying to assist in eliminating the cause of these failures?

Dr. MCRAE. Where that is indicated; yes.

The CHAIRMAN. What have you done?

Dr. MCREA. Well, in most of the cases, the effort that is applied to these problems immediately upon their occurrence is so very great that by the time we look at it it is a question of making suggestions as to slightly different approaches or changes in attack, and we have always found in each of the cases in which we have looked into these that the efforts were being applied in generally the same way as we would recommend them to be applied.

The CHAIRMAN. In other words, the departments are going ahead and proceeding just as you would recommend in most cases. That

eliminates most of the responsibility from your committee, doesn't it?

Dr. McRae. In what sense, sir?

The Chairman. Well, it——

Dr. McRae. It makes our responsibility easier to carry through, sir.

The Chairman. Mr. Sisk.

Mr. Sisk. I just briefly read your statement, Doctor, and it seems to me that it is a very optimistic statement. There are only two comments I have to make. I notice one statement in which you say, "to date I would say that the ballistic missile test program, taken as a whole, should instill a feeling of confidence rather than doubt that success will be achieved."

That, in essence, sums up your feeling. Now, the other significant thing that I note in your statement is that due to the fact so-called partial failures have not been due to specific design deficiencies, rather than what might be failures of various things, would lead you to feel that it would be unwise to make any change or drastic alteration in test programs. As I say, that is a very optimistic statement, and I am very happy to hear it. Sometimes we hear statements going in the other direction. I appreciate these statements, Doctor.

Dr. McRae. Could I make a brief comment, Mr. Chairman, because I think this point is very important. Why is it that I sound more optimistic? Perhaps it is because I am not looking at each test as a kind of baseball game where somebody is going to win and somebody is going to lose. This is a tendency that we all have—to look at any of these events as black or white events. Instead, those of us who are close to the program are looking at them in terms of the kind of information that Admiral Raborn told you about this morning, and General Schriever yesterday. Even the poorest tests provide information; I mean, even the ones that look poorest to the spectator often provide the most information.

Mr. Sisk. That is a very good statement, Mr. Chairman.

That is all.

The Chairman. Mr. Fulton, any questions?

Mr. Fulton. With respect to a possible change of policy, on the various components of these missiles: First, is there work being done on the standardization of components so that once tested out on one type they can be used interchangeably on another?

Dr. McRae. I believe that the present state is rather more the state in which different components are being frequently used in order that there will be more assurance of success; that is, if one fails, you will be able to use the other. We have not yet reached the time when significant standardization measures among missiles are a matter of first importance.

Mr. Fulton. That is the reason I am bringing the question up. Should we now begin looking for a standardization of proved components so that they are interchangeable between missiles, and the ones that are not operating satisfactorily on proved components then be eliminated?

Dr. McRae. I don't think, yet. I don't think we have enough information yet on the various components.

Mr. Fulton. The second problem is this: We are talking of operational capabilities of the overall missile configuration generally,

rather than the operation capabilities of the various components. My question is this: Why shouldn't we have a time on the various components—say the jetevators or the verniers, or the tankage, or the various components of guidance or, for example, on the hydraulic systems that release, or on the electrical systems or electronic systems? Why don't we have a time when those components must be made to function or the contractor at fault shall then be penalized? For example, on these experiments that the Air Force has had, one was a hydraulic failure on ground equipment, another was electrical system failure, another was failure to shut off a liquid oxygen valve. On that type of failure, that has nothing to do with experimental failure and is a component failure just like a component in a proved aircraft failing. During World War II, I served on the aircraft scheduling units, scheduling plane production for the U.S. Air Force. I was the Navy representative on that. Our problem there was to find out where the bugs were on a lot of this equipment and standardize it and come up with the basics so that we could get them done and move on then to new models.

Now, you see, if that same principle were applied here, we come to the point where when we hear that somebody failed to close an oxygen valve so that the feeding system isn't working, or that the hydraulic system on a ground operation is not in perfect working order, or that the electrical equipment—there is a short or a loose connection—haven't we come to the point where we can say to the contractor, "If you don't come up to a higher standard on that you are going to get penalized, you are going to have to put up a bond on it"; are we there yet?

So many of these failures look to me as if they are just plumbing and electrical wiring failures.

Dr. McRae. That is not an easy question to answer, as I presume you understand.

Mr. Fulton. You could put that into the record later.

The Chairman. Any further questions?

Mr. Miller. Mr. Chairman.

The Chairman. Mr. Miller.

Mr. Miller. I just want to say this to Dr. McRae: How long have we been in the missile business now—about 12 years?

Dr. McRae. Well, we have been in the missile business, I suspect, since 1946 or so.

Mr. Miller. 13 years. Now, at the end of the 13th year after the Wright brothers made their historic flight at Kitty Hawk, which would mark the kickoff of the airplane business in this country, how much further are we now on the missile than we were in 1916 on the airplane?

Dr. McRae. First, you have to be a little more precise in what you mean about missiles. We have some solid propellant operational missiles in use, and have for quite a long time. These are air defense missiles, but you are speaking of ballistic missiles. You are speaking about intercontinental and IRBM's. Well, the fact of the matter is that we did not put emphasis on these missiles until—what was it—1953 or 1954?

Mr. Miller. 6 or 7 years?

Dr. McRae. Yes. We were making a logical decision: Until you could see the payload, until you could get small H-bomb warheads, there was no sense developing a missile to carry a small payload. So we made this logical decision, not having faith that we would come to small warheads as soon as we did.

Mr. Miller. The thing is, we have made more progress in this field, as a whole, than we made in the field of the development of the airplane or the automobile or the telephone, or anything else in the same comparable age group?

Dr. McRae. Much more, sir.

Mr. Miller. The telephone or the wireless or the automobile or the airplane—when they were 13 years old, they were still in short pants compared to where we are now.

Dr. McRae. I certainly agree.

Mr. Miller. So we haven't anything to be ashamed of. I think if we quit thinking of where the Russians are and try to get down to brass tacks and see what we can do and get our job done, we still be better off. That is my own feeling.

Dr. McRae. I agree thoroughly.

The Chairman. Mr. Anfuso.

Mr. Anfuso. I just have one question, Doctor. We are very fortunate to have a man of your background and experience here. I would like to ask your opinion as to what you think of putting the Polaris missile on cruisers.

Dr. McRae. I suspect that this comes under the general philosophy that the best kind of a deterrent is not only one that is difficult to locate, but it is also difficult to determine just where and how it will come. Therefore, you should, I think, look toward having your deterrent missiles on every vehicle and every location in the most variety of situations you could imagine. Therefore, as a general principle, yes, on cruisers.

Mr. Anfuso. Thank you very much.

The Chairman. Doctor, may I ask you one question?

Dr. Herbert F. York, on July 18, made an address. In that address he said—

We have gotten somewhat frantic about catching up with the Russians. Most of our failures have been due to somebody taking a gamble, not being able to think things through, or trying to save a month or two, taking a chance that something would work.

What would you say about that statement? Do you think that is correct, that we are frantic?

Dr. McRae. I don't think so, myself. I believe the chances that are being taken are sensible ones, and I think these failures would occur no matter if you took a longer time in between each test.

The Chairman. Just like the bugs in a new airplane; you have got to use them and iron them out gradually; is that it?

Dr. McRae. That is right. Everybody knows that the automobile is a practical gadget. Yet the one I bought a couple of years ago had to have an expensive change in the rear end because it wasn't built right.

The Chairman. One more question. Your committee has charge of intercontinental ballistic missiles. Does your committee include in that vehicles, too; for instance, space vehicles?

Dr. McRae. No, sir.

The Chairman. That is not under your jurisdiction?

Dr. McRae. Only insofar as they are in the Department of Defense, which makes them really only the military ones.

The Chairman. Well, the Atlas is a space vehicle, too.

Dr. McRae. We look at it from a military point of view.

The Chairman. If there are no further questions, thank you very much, Doctor, for coming here. We appreciate it.

(The statements of Admiral Raborn and Dr. McRae are as follows:)

Statement of Rear Adm. W. F. Raborn, USN Director, Special Projects

At the very outset, I should like to express, in behalf of the entire group working on the fleet ballistic missile program, that we welcome this opportunity to provide this committee with the full facts on the status of the Polaris missile.

My purpose is to supply within security restrictions the picture as it stands today, and the prospects for integrating the fleet ballistic missile into the nuclear powered submarine on the schedules that have been set.

If classified details are required I am prepared to present that material in closed session.

We stand ready at any time to provide all Members of the Congress and the general public, too, with a documented, realistic appraisal of where this program stands.

A few remarks now regarding the importance of the FBM system. I consider that this weapon system is one that our Nation has to have to deter any possible enemy from starting—or even to consider the start of—a general (total) war. The Polaris weapon system is unique in that it combines the mobility and relative invulnerability of the nuclear powered submarine with an IRBM to give our Nation, in effect, a worldwide ballistic missile capability yet subject only to U.S. control. It will always give us the ability to react in event of missile attack on our Nation—we have time for mature decisions. It is one weapon system that the United States has to have—it needs others, too. I am happy to report that we will have this system in 1960.

Now for a little information on the fleet ballistic missile system with specific reference to Polaris the missile:

As you know, it is a complete weapons system package development program requiring development and production of the Polaris missiles, nuclear-powered submarines, submarine tenders, shore supporting activities, and industrial base, all carefully integrated to move forward in step with each other. As one example, the Polaris missile development schedule is keyed to meet the first submarine in 1960. As weapons system manager, it is my responsibility to keep these component parts moving in parallel development with later joining to form an effective FBM system which is unique among all ballistic missiles. Your interest today is primarily in our missile, Polaris. It is a two-stage, solid-fueled missile. The missile had to be small, light, and compact because of space and weight considerations in a submarine—and a submarine load of Polaris missiles is 16. For reason of safety, the decision was made to use solid fuel. Shelf life, safety, and maintenance are other key considerations, since they will be submarine borne for months at a time. The missile itself must remain dependable to withstand the effects of rough seas and salt water. It must be built to allow access to its parts for checking and preventive maintenance in the confined areas available on ships.

At the very beginning of this Polaris program we called in from industry and from our various technical laboratories the best qualified people to deal with all phases and all major components of this new ballistic missile weapons system. For the missile, problems of prime consideration were development of high-energy propellant, satisfactory motor cases using light material, missile directional control, precise motor cutoff, guidance and reentry—all to fit within a small missile for submarine use. During a concentrated study of more than 3 months' duration, we forecast the technical state of art some 5 years in advance for each of the various parts of the missile to bring clearly into focus all technical objectives so that at the end of the development period we would have the most modern and up-to-date missile that would be possible. As a result, our development test program got off to a good start and has kept on

schedule throughout its duration. We have not had to change—and have not changed—any basic parameter of our system since we completed—and implemented—the study I previously referred to some 2½ years ago.

Before discussing specific points let me state that we have made excellent if not outstanding progress in meeting the objectives planned within the accelerated time scale. Here in simplest terms is the way our technical staff and advisers have rated the 33 flight tests we have made. This is the significant score to date. Of the 33 launchings of test vehicles, 24, or slightly better than 2 out of 3, were completely successful in that all specific technical objectives were accomplished.

Seven of the 33 were rated partial successes in that 1 or more of the primary technical objectives were achieved.

Two launchings were failures. None of the primary objectives were achieved. We learned from these failures but the information was far less than we hoped to obtain. These failures, incidentally, were due to malfunctioning of relatively minor and simple elements. We wish they had not happened. They might have been prevented. They have not reoccurred.

Today my main remarks will relate to four basic points which I believe to be of greatest interest to the members of this committee in assembling the facts on our missile development.

First, where do we stand in relation to our scheduled development timetable? I am happy to be able to say that we are meeting our most recent accelerated schedule of "target dates" and that we can confidently predict that there will be operational Polaris submarines with missiles available for deployment at sea by the end of next year. In 1960 the operational fleet ballistic missile weapons system will be an element in our structure of defense.

Second, to report the technical status of the missile system as such, to provide our honest answer to the all-important question: "Will it work?"

On this point, we have every reason to be confident that we will have tested dependable Polaris missiles, have them assembled and ready when the first specially designed submarine is ready to receive them, so that the final phase of the total test program can be devoted to operational factors of the entire weapon system rather than to validating the performance of the missile as such.

Third, to identify and clarify the nature and scope of the missile development test program to date.

Despite what impressions there may be to the contrary, no operational type Polaris missiles have yet been fired. No such missiles are scheduled to be fired until sometime in the future. What we have fired in this program have been various configurations of flight test vehicles to gain information on various missile components in a flight environment and to determine the compatability of the missile subsystems. I will cover this in more detail later.

Fourth, and finally, to tell you what we have learned from these tests, what we expect from the balance of this development program, and what we plan to do between now and the departure of the fleet ballastic missile submarines to their assigned stations of operational deployment.

In regard to the timetable of this program, it is important to recognize that the basic "target date" of the entire program, the delivery of the first operational missiles and submarines to the fleet, has been accelerated by about 3 years since the fleet ballistic missile program was authorized less than 3 years ago.

Specially, this date was advanced from 1963 to about 1960. These accelerations were made possible by the substantial progress in systems development, coupled with a few major technical breakthroughs. Had not our development program been so successfully productive, it would not have been possible to respond to requests for our best possible schedule.

We have had two major breakthroughs during the missile development, one contributed by the AEC and the other a Navy achievement in the field of solid propellent fuels. The tests to date have provided verification of basic design decisions, but further substantiation is necessary to fulfill our reliability requirements for a seaborne missile. We have had no serious setback of a technical nature in terms of the basic design of the missile systems, and no situations calling for major redesign of any prime component. We have obtained a feedback of information on the types of necessary adjustments we expected to find out through these tests, and I am happy that they are becoming known to us in the early stages of our present flight test vehicle program so that solution can be tested and proved well in advance of our 1960 target operational date. I repeat, we have uncovered no situations calling for changes beyond the engi-

neering refinements normally expected in developing any new and complex mechanical, chemical, and electronic device. We require no further breakthroughs.

Let me describe our missile development program for you.

This program can be divided generally into two major areas: static and ground tests of all descriptions, and flight tests. In the static test program, various components of the missile are separately tested in many configurations. Data is taken and analyzed with the aim of improving the next model of the component. As favorably tested configurations of components are obtained, the components are put together in increasing numbers and finally we have a complete portion of the missile. This larger component, in turn, is statically tested with variations to obtain the most optimum combinations. When we have gained all of the information feasible with ground tests or static tests, we then conduct flight tests to prove out the conclusions reached from the static tests and to carry the components into the actual environment in which they will be required to operate. The flight test provides the crucial environment in which the vehicle and all of its components must be made to operate satisfactorily in order that we may have a fully acceptable bird for shipboard use. Because these flight test programs are expensive, we endeavored to utilize, in the early phases, smaller versions of flight test vehicles which were entirely adequate for the test objectives under consideration and yet are not as expensive as a full scale test model.

The Polaris development program has been carefully blocked out in major technical performance areas to develop the individual components of the missile according to a preplanned requirement. Then step by step, the type of hardware which will be most suitable for the operational type missile is ground and flight tested.

Take the warhead reentry body, which, of course, is a combined responsibility of the military and the Atomic Energy Commission. Here, a team of Navy and AEC scientists have collaborated to bring forward the warhead reentry body combination with which the Polaris will be equipped. The selection and type of materials to overcome the intense heat of reentry, shape, and type of the atomic bomb, the arming and fusing of this warhead, all are separately tested out on the ground and then the various components of the reentry body are flight tested to prove out the validity of the information gained from ground tests.

Similarly, while this is being done, the missile guidance is being put together and subjected to a whole series of tests. First, the individual components—the gyros, the accelerometers, and the stable tables are put on high speed rocket sleds at our several test stations and subjected to the rigors of high speed accelerations and the shock and vibration conditions which may exist in flight. Whirl tests on centrifuge test devices and many other tests are done on the ground on the individual components of the guidance system and finally on the completed package. At this time, the missile guidance as a whole is put into the flight test vehicle and given its preliminary flight test.

The Polaris missile has two propulsion stages; each stage has a motor. Development of these motors is a distinct feather in the Navy's cap and we're quite proud of the way that this program has progressed on schedule. Building on its years of experience in solid propellants, the Navy was bold to strike out on its own some 3 years ago seeking satisfactory solid propellant motors for the Polaris ballistic missiles.

Here the motor case, the propellant itself, the devices that control direction of the missile motors, and the thrust termination devices are checked to a considerable degree by static and ground tests before getting into the air and into space in our flight test program.

If we look at the development program of each of these components—reentry body, guidance, and the solid propellent motors—we will see that we set for ourselves certain technical goals and objectives. These objectives with the results to date may be listed as follows.

REENTRY BODY

Our objectives in this program for the first year and one-half were the development and test of components of the reentry body design. Because of space and weight considerations, we had to crowd all reentry body components into a small package and save weight in many ingenious ways. Hundreds of hours were spent in ground tests (wind tunnel, shock tests, etc.), using existing Govern-

ment and industrial facilities. Many airdrop and flight tests demonstrated the suitability of the design. Of interest is the fact that while our particular design concept was considered radical, the validity of our concept has been accepted by other activities engaged in developing ballistic missiles.

During the past year (ending July 1, 1959) it was planned to confirm basic design parameters by flight and ground tests. This has been achieved.

Remaining development work is to conduct flight tests with a dummy warhead as passenger and to obtain additional verification of the initial operational design by flight tests.

GUIDANCE SYSTEM

Objectives of this program were to design and develop the components and test them in ground and flight tests to assure meeting ballistic missile requirements. Because of the small size of the Polaris missile, an extremely small guidance package had to be devised. For the first year and one-half, a number of flight and sled tests, over 200 other environmental tests using ground facilities and innumerable circuit design and compatibility tests, have demonstrated the suitability of design and durability of the components.

Our objectives during the past year were the firming up of the hardware for the overall guidance system and furnishing of these systems for flight and ground tests and fire control checkout purposes. These objectives have been accomplished.

Work planned from now on is keyed to qualification, by flight vehicle tests and ground tests, of the guidance system for the 1960 operational missile.

PROPULSION SYSTEM

Our objectives, which were met, in the propulsion system development program for the first year and one-half were development and test of the following components and techniques:

(1) High-energy propellants for ballistic missiles application, (2) thrust termination scheme, (3) jetevators as a means of thrust vector control, (4) lightweight motor case materials, and (5) propellant and motor cases manufacturing techniques. Numerous full-scale and small-scale motors were ground tested and several vehicles were flight tested for various purposes.

During the past year, it was planned to qualify the motors for full-scale vehicle tests. The latter phase required the confirmation of reliable motors with the higher specific impulses demonstrated earlier in motor firings. Again numerous full-scale and small-scale motor ground tests and additional flight vehicle tests were conducted. A high degree of confidence in powerplant design has been achieved. Current objectives are to confirm all aspects of the powerplant design for the 1960 operational missile by flight and ground tests.

With this general outline of the Polaris missile subsystem development program for background, I would now like to take up groups of Polaris test vehicles and tell you something of the nature of the results we have obtained on which we base our assessment of progress.

The first group of flight test vehicles were especially configured to allow us to successfully develop instrumentation, telemetering, and analysis techniques while, at the same time, obtaining some information on thrust termination.

Flying the second block of flight test vehicles gave us much usable information on thrust termination. From a third group of flights, using another configuration vehicle, we obtained valuable information and confirmed many aspects of reentry body shapes, materials, and behavior.

In another block of vehicles we obtained verification of design concept for flight control components and the effects of thrust termination.

The fifth group successfully tested flight control concepts using early developmental hardware and gave us valuable environmental information on guidance system components.

By another block of test vehicles, we proved feasibility of underwater missile launching and compatibility of the missile and the launching tube. This was achieved by many successful launchings: from our pop-up facility off the California coast—including some conducted through waves generated by cruisers—from our land-based launcher, *Peashooter;* from our ship motion simulator at the Atlantic Missile Range, and from our weapon system test ship the U.S.S. *Observation Island.*

Last September, on the accelerated schedule, we commenced flight testing of the first development model of the 1960 operational missile. This flight test

vehicle incorporated for the first time in one vehicle those components developed at that point in time in the program. The previously developed systems—reentry body, powerplant, the ballistic shell, flight controls—were married so that integrated missile system flight tests could commence. We conducted captive tests at our Santa Cruz, Calif., facility of the "integrated" vehicle prior to commencement of flight tests. This gave us assurance of overall system compatibilty and operation on the ground.

Before discussing the results to date of the flight tests with this "integrated" test vehicle, let me state that this was a major sep forward and we knew and hoped that we would uncover deficiencies. We expected more problems in this phase than we had experienced in development of the missile subsystems. I knew, however, that basic design of the individual subsystems had been proven and that any problems unearthed would be susceptible to straightforward engineering solutions. I am pleased that we have uncovered no major problems to date and that we have obtained all the information we planned and more than we expected and required at this phase of the development.

To date, in "integrated" missile system test vehicle firings we have confirmed compatibility and operation of the overall system less guidance in three fully successful flights. We have achieved repeated motor stage and reentry body separations, thrust and flight control operations, reentry body operational confirmation and second stage motor ignition, and guidance system operation in a flight environment appears good. There have also been problems as we have proceeded with the flights. Some of these we consider random, others were attributable to vehicle components required only for range safety or evaluation purposes—all of the problems uncovered in the partially successful and the one unsuccessful flights of these test vehicles have been solved or solution is in sight.

The work ahead of us involves demonstration and confirmation of missile guidance control, ship motion firings from our ship motion simulator, flight tests from surface ship and submarine and proving repeatability of complete missile operational sequence. For our 1960 operational missile, we are well advanced developmentwise on lightening up structures, increasing propulsion power, and removal of a great deal of instrumentation not required for tactical missiles which is necessary for—and so heavily weighs down—our flight-test vehicles. We plan on firing the first prototype 1960 operational missile late this year.

I expect problems ahead of us but I know we can handle them. In summary, we have met or exceeded every objective as scheduled for the development program.

Against this general background of Polaris missile development test program, I will describe briefly the results of the most recent flight test conducted about 2 weeks ago, on July 15. To a casual observer, this test might be considered an apparent failure. In reality, from a point of view of getting a successful missile, it was stimulatingly successful. One of the primary purposes of the flight was to test the missile brain. Although the test vehicle went into unexpected acrobatics, the missile brain performed beautifully even under most vigorous conditions. On takeoff, this bird lost part of a jetevator—something which has never happened in any previous flight. This jetevator was recovered and is now undergoing intensive metallurgical and other tests as a basis for developing inspection procedures to prevent a recurrence. The acrobatic behavior of the test vehicle established a test condition for the missile brain we could never have planned. The ruggedness and the performance of the missile brain in this test were so outstanding that we are considering foreshortening this phase of the missile development. Since the primary objective purpose of the flight was to gain information on the adequacy of the guidance component in a flight environment, it was a most significant and helpful milestone. I have a movie of this flight which I will be happy to show you in closed session.

I do not believe that this point of flight test evaluations can be overemphasized. The success or failure of individual tests whether they be the spectacular type of tests conducted at the Atlantic Missile Range or the thousands of tests in closed laboratories must be measured in terms of contribution toward ultimate goals.

I recently read with interest the staff report of the DOD Subcommittee on Appropriations, House of Representatives, 86th Congress, titled "Reliability Efforts in Ballistic Missile Programs." In this report it was noted, and I quote:

"Managers of missile programs are required to make extremely delicate and difficult decisions in trying to achieve optimum balance between such factors as weapon capability, weapon reliability, and cost. One of their managerial re-

sponsibilities is to temper haste with caution; and a mistaken public reaction can subject them to undue pressures from outside, thus complicating critical decisions. Managers may be tempted to avoid making tests which are necessary, but which would look like failures, or to make spectacular tests of little engineering value, or to advance firing schedules for propaganda purposes."

In the Polaris program we have adhered to strict technical discipline in all of our testing, including decisions to fire the "integrated" missile flight test vehicles.

Finally, the outlook for this missile development test program is as follows:

We plan on continuing our full-scale flight test vehicle firings from Cape Canaveral and to begin live firings afloat from our weapon system test ship, the U.S.S. *Observation Island*, this year. We will continue the underwater launching test program from the ocean bottom off the California coast.

Next year, when the first Polaris submarine will be available, the first missile firing from a submerged submarine will take place.

Every step taken in the tests to date, and to be taken between now and that time, has one purpose in view. That purpose is to make certain that every component in the system will function dependably and efficiently. This purpose is to remove every possible element of uncertainty in advance.

As of today, and based on analysis of all data at hand, I feel, and state again, that we have every reason to predict success in achieving a dependable missile system by the end of next year.

Under current appropriations, nine fleet ballistic missile submarines have been authorized. Additional units, if authorized, could follow at intervals of about 1 month. The number of submarines to be built and the number of missiles to be provided for them will be determined, of course, by national policy, through its legislative and executive authorities.

Our responsibility as the development team is to design, test, and produce hardware which can be depended upon, should the need for the fleet ballistic missile weapon system ever arise, to do its job with certainty.

I am glad to be able to report that such a Polaris weapons system is clearly in sight.

STATEMENT BY DR. JAMES W. MCRAE, VICE PRESIDENT, AMERICAN TELEPHONE & TELEGRAPH CO., AND MEMBER, DEPARTMENT OF DEFENSE BALLISTIC MISSILES SCIENTIFIC ADVISORY COMMITTEE

Mr. Chairman and members of the committee, my name is James M. McRae. My occupation is vice president of the American Telephone & Telegraph Co., responsible for the defense activities of the Bell System. I appear before you today as a consultant to the Department of Defense and member of the Department of Defense Ballistic Missiles Scientific Advisory Committee—a committee appointed by the Secretary of Defense to advise and assist the Department of Defense in matters of technical policy relating to the national ballistic missiles program.

It is my understanding that this hearing is being held because of your concern about failures in recent test firings and the implications of those failures on the success of our ballistic missile and space programs. I also understand that qualified representatives of the agencies responsible for the various test programs are available to give you an analysis of the test results in each of the programs, including the specific causes of failures where these occurred and the corrective measures taken in each case. Accordingly, with your permission, I will confine my remarks to the nature of complex development programs, the reasons for having tests, the kinds of tests which are required, and the significance of the tests in establishing confidence in the final product.

The creation of an intercontinental ballistic missile system is a tremendously complex and difficult undertaking. At the outset the number of scientific and engineering problems requiring solution, although different in nature, were at least as great in number and complexity as those associated with the creation of the atomic bomb. Success could not be achieved without extending the frontiers of knowledge and technology in every major technical area: aerodynamics, propulsion, electronics, mechanics, materials, instrumentation, etc. The development of the many system elements was further complicated by the almost total lack of knowledge of the environment in which they would have to operate. The temperatures, accelerations, vibrations, noise, and radiation levels to be

supersonic and the flow of gas out of the nozzles was diverted a bit, depositing metal particles around the jetevators, causing them to bind. So what we did then, we had two of these happen that gave us difficulty on certain performance out there in flight control. We took the seals out, put a little baffle behind them, and we have had no further trouble.

Now, we had two others of these partial successes which had rear end heating—the end of the motor heated up. This was also caused by the diversification of the smooth flow of air down the side of the missile when it went transonic, causing the rear end to get an unusual shot of heat. And so what we have done there is to get some very lightweight insulation and put over the end of this, and we have had no further trouble. That is the nature of the partial failures.

The CHAIRMAN. Mr. Sisk.

Mr. SISK. No questions.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. How many submarines of this Polaris type are programed now for the United States?

Admiral RABORN. We have nine approved and under actual construction, sir. We have long leadtime for three additional submarines in the 1961 budget.

Mr. FULTON. How many were requested by the Department as being necessary for our security; how many did you originally request; and how many were given of that request?

Admiral RABORN. The Department of Defense requested this number and received that number.

Mr. FULTON. So there is no difference between the number the Department feels are necessary for U.S. defense and the number that you have under construction?

Admiral RABORN. That is correct.

Mr. FULTON. How many of these missiles are carried per submarine? I see you have a certain number on this model.

Admiral RABORN. Yes, sir. There are 16 missiles per submarine.

Mr. FULTON. How long is the life of the missile? How long can you have the fuels put in the engine and then held in the container? How long will the firecracker last?

Admiral RABORN. We are conducting aging tests on our propellant. The nature and characteristics of this propellant are considerably better than that which we have experienced in the past, and normally a solid propellant motor has been thought usable somewhere between 3 and 5 years, depending upon the specific nature.

Now, this leads us to think that perhaps these motors would be most usable up to 5 years.

Mr. FULTON. So there is no limitation on the life of the missile as to the length of time the submarine can be operational?

Admiral RABORN. That is correct.

Mr. FULTON. Then with 70 percent of the world's surface composed of water, and with a 1,500-mile range, approximately what percentage of the world's strategic areas can this missile cover? I would think it would be some very high amount, wouldn't it, because with 1,500 miles on either side you could obviously cover the whole North American Continent and South America, as well.

Admiral RABORN. That is correct. We have, of course, studied this problem and the general conclusions of our studies are with a 1,500-mile missile, in a ship that can move around and approach the coast, there are no significant military targets that we know of that could not be brought under or threatened with this type of weapons.

Mr. FULTON. And likewise, large nuclear or manufacturing targets could all be brought within the range of this weapon?

Admiral RABORN. Yes, and without doing a thing to the submarine, we believe we can improve the range of the missile. This is the history of all weapons systems, they are improved in performance as we go along.

Mr. FULTON. Now, this missile can be used on surface ships or stationary rafts, as well as submarines?

Admiral RABORN. That is quite feasible; yes.

Mr. FULTON. The advantage of the Polaris is that the base is maneuverable, and therefore it cannot be quickly counterattacked?

Admiral RABORN. We feel that the mobility and concealment which is inherent in a submarine or on a surface vessel, do not make them targets for ballistic missiles, cannot be successfully attacked by ballistic missiles, and we feel that they make them—give them one of the major elements of any good major war deterrent, and that is the fact that it cannot be zeroed in ahead of time and marked for quick destruction. It is going to be there when you want to use it, and that is one of the fine virtues of this system.

Mr. FULTON. Now, on discovery, once the shot is made, of course, there is going to be an ionized trail left when the missile gets going under its own power, as distinguished from compressed air. What of that? Is there a great possibility of detection, Admiral?

Admiral HAYWARD. Well, Mr. Fulton, once you shoot the missiles, with the reaction time you have with the solid propellant, the missiles will be shot. If you lose the submarine, that is part of the deterrent system. We hope, of course, that it is never used. If it is used, the deterrents have failed, obviously; and in regard to the mobility, we in the Navy—as you know, Horace Greeley said "Go west"—in the deterrent business we say "Go to sea, get mobility and concealment."

Mr. FULTON. Then there is the question of your target error, the CEP, circle of probable error. Are you able to say just how big an error that would be?

Admiral RABORN. Not in an open session.

Mr. FULTON. One of the officers said you could hit the ballpark but aren't able to put it in the reserved seats.

Admiral RABORN. We expect to hit the ballpark.

Admiral HAYWARD. Everybody knows the inertial physical principle of the Schuler pendulum. You can figure it out. This is the component work. Of course, when the CEP's come down, it makes the fixed systems even worse.

Mr. FULTON. One other thing. You had shown in development certain sizes. Actually, you have never changed from your conception as to target size?

Admiral RABORN. We developed these goals 3 years ago and we have found they were very good goals to shoot for.

Mr. FULTON. What is the operational cost per missile in dollars? What is your estimated cost apiece when you get these operational?

Admiral HAYWARD. Do you amortize it over the life of the vessel? This is an awfully difficult question, Mr. Fulton, the actual cost of the operational missile on target. You can get any figure you really want. The life of the submarine is 15 years.

Mr. FULTON. Terriers cost about $40,000 apiece, installed. What would these cost?

Admiral RABORN. We expect the operational missile to run about $1.2 million apiece, less warhead.

The CHAIRMAN. That would depend on whether you charge all of this scientific investigation to the individual missile or whether you cut it off and just simply charge the construction after it is perfected?

Admiral RABORN. That is correct. We get any number of figures. I am very glad to say that we have been required by the Navy to budget for everything that goes into this whole weapons system. It is my responsibility to handle the funds for everything from construction of that submarine, development of the missile, selection and training of the personnel, all of the test work, and we do have for the first time, I believe, certainly in the Navy, good estimates of what it takes to bring a system into being and what it costs to operate it.

Mr. FULTON. Of course, on a missile of this size somebody could calculate very readily what your kiloton capacity is. Is that public?

Admiral RABORN. No, sir.

Admiral HAYWARD. Do you mean kilotons in payload, Mr. Fulton?

Mr. FULTON. Yes. That isn't public?

Admiral RABORN. No, sir.

Mr. FULTON. I want to congratulate you and say that we are very proud of the Navy and its program and the results that you have, and say to you that I think this is one of the best missiles we in the United States have, because of its concealability and maneuverability.

Admiral RABORN. Thank you, Mr. Fulton.

The CHAIRMAN. Mr. Miller.

Mr. MILLER. I have no questions, but I do want to compliment you, Admiral, on part of your statement. You showed you were introducing some of the "soft" sciences into the work of training your crews. This is a little different from the "soft" sciences in the Navy, which used to be a cat-o'-nine-tails, so we are making progress in that direction, which I think is just as important as some of the hard sciences in these fields, and I want to congratulate you upon that.

Admiral RABORN. Thank you, Mr. Miller.

The CHAIRMAN. Mr. McDonough.

Mr. MCDONOUGH. I just want to compliment the Admiral on the very clear understandable exposition and revelations he has given us this morning in the operation of the missile. I think he has done a remarkably fine job. I am very hapy to hear that your schedule is ahead of our potential enemy.

Admiral RABORN. Thank you, sir.

The CHAIRMAN. Admiral, you seem to be very popular in these parts.

Mr. Teague.

Mr. TEAGUE. No questions, Mr. Chairman.

He might tell me where he is from.

Mr. DADDARIO. No questions, Mr. Chairman.

The CHAIRMAN. Mr. Anfuso.

Mr. ANFUSO. Mr. Chairman, I have a few questions to ask, and I, too, want to congratulate the Navy in this particular enterprise. I, think, Admiral, that all of you men seated there have developed something which could change this whole method of waging war—and let's admit the fact that we are at war. A lot of people seem to think that we are not, but Russia is certainly at war with us. I think that you have developed something which could change our entire method of warfare and give us an advantage.

We all know that the ICBM sites can be wiped out by the enemy. If they know where one is all they have to do is aim for it and they can wipe it out. That cannot be done with these submarines, because they have to be pinpointed, and it is very difficult to pinpoint them. So the possibility of destroying them is not very good.

Now, if, Admiral, we are to narrow the missile gap and gain this advantage that I am speaking of, then in view of the present slow development of our ICBM, would it not be practical to install Polaris missiles on surface ships, such as cruisers?

Admiral RABORN. We have conducted studies on this, as you would expect, to explore possible exploitation of the weapons. We have found that the system which we will put aboard submarines is quite adaptable for cruisers.

Mr. ANFUSO. Thank you. Now, wouldn't such missiles in effect become ICBM's by having the capability to strike almost all of the same targets as ICBM's, which you say can go 1,200 to 1,500 miles, that the United States could strike?

Admiral RABORN. They could be ICBM's in range. The ICBM's we are constructing, of course, carry a larger payload, but from the range standpoint they certainly could be classed in an ICBM category.

Mr. ANFUSO. And isn't it a fact also that Polaris missiles installed on surface ships would be more truly mobile, less vulnerable, and therefore more effective even than the Minuteman missiles installed on railway cars proposed for the sake of obtaining mobility?

Admiral RABORN. We are understandably proud of the many advantages of this system, sir, and I think that, with due deference to our sister service and their missile programs, that we would agree to that.

Mr. ANFUSO. Wouldn't the further development of this program do this: It seems to me that the Polaris missiles aboard cruisers or other surface ships would complicate the defense picture of the enemy.

Admiral RABORN. We believe that the mobility by putting the missiles on ships at sea would greatly complicate the defensive measures which any potential enemy might take to counter them.

Mr. ANFUSO. Wouldn't the enemy have to change his defense plans to a considerable degree to take on this account?

Admiral RABORN. We believe that is so. The fact that you cannot zero in an appropriate number of weapons to knock out a fixed position, because these would be under the sea or on the surface of the sea and moving around, certainly would cause the enemy to take another look, if you please, should he ever get to the position where he would have enough ICBM's or other weapons which he might calculate he could knock out in a swift surprise blow. This is one of the inherently tremendously fine advantages of mobility of ships at sea.

Mr. ANFUSO. In other words, instead of following the Russians, we could by this process take the lead and have them chase us around for a while and wrestle with developing new modes of waging warfare, which could eventually bankrupt them. They are trying to bankrupt the so-called capitalistic countries.

Now, if we give them a little run-around they will have to develop constantly new methods in trying to catch up to us. Isn't that right?

Admiral RABORN. I believe that this certainly is so, and this weapons system, when we finally get it, is going to prove to be one of the most attractive major war deterrent weapons systems which we will have in our national bag of tricks. Now, I would like to emphasize the word "deterrent," because if the deterent fails, as Admiral Hayward mentioned a few minutes ago, the primary purpose of these weapons has failed, too. No one wants an all-out war, and if we can increase the psychological effect of deterrents so that the enemy will never start a war, a major war, it then is a most successful system, and this is one of the principal potentials of the Polaris in ships at sea, that it does away with anyone getting so assured that they can start a war and knock out his potential enemy without being harmed.

Mr. ANFUSO. Automatically, Admiral, the installation of these missiles on cruisers and submarines would at once make these vehicles, these ships, suspect; isn't that right?

Admiral RABORN. Yes; that is right.

Mr. ANFUSO. Because the enemy would have to again develop a method of attacking them?

Admiral RABORN. Every submarine at sea becomes a potential Polaris carrier, until it is proved otherwise, and we all know how difficult it is to identify the type of submarine or even find a submarine at sea.

The CHAIRMAN. Mr. Anfuso, may I interrupt you just a moment? We have scheduled this morning Dr. James W. McRae, vice president of the American Telephone & Telegraph Co., and member of the Defense Ballistic Missiles Scientific Advisory Committee. Now, we are not going to have time to hear him this morning, and I am wondering if the Doctor would be able to return here. We have two bills scheduled for tomorrow, and I wouldn't want the Doctor to go through the same waiting period tomorrow. I am wondering if it wouldn't be all right sometime next week to call him as a witness.

Dr. MCRAE. Mr. Chairman, it occurs to me that perhaps my contribution to this hearing can be quite brief and could consist of any questions that you care to direct to me, since you have the statement.

The CHAIRMAN. Normally I would say yes; that would be fine, but I do know that we are going to have two votes on the floor of the House just after they convene, and so whether or not we would be even be permitted to stay for questions I can't say. If you want to take the chance, we will be happy to work it that way.

Dr. MCRAE. I would be delighted to do that, sir.

Mr. ANFUSO. Mr. Chairman, I have just two short questions and then I am finished.

Now, Admiral, would the installation of Polaris in a cruiser, for example, interfere with its basic mission?

Admiral RABORN. Certainly not, sir.

Mr. ANFUSO. Regulus II, which was canceled because of the development of Polaris, was planned for certain cruiser installations. Would there be any particular construction difficulties in these cruisers now being built or converted which were originally scheduled for Regulus II?

Admiral RABORN. The space and weight requirements for Regulus, of course, would be available to be utilized by the Polaris weapons system installation. Our requirements of launch tubes, and so forth, are quite different from that, of course, for the Regulus, but our studies have indicated that they can be placed aboard these cruisers on a normal conversion or new construction with a minimum of ship construction difficulties.

Mr. ANFUSO. Now, finally, Admiral, I think you said before that there was perfect coordination between the Navy and the other agencies—the Army and the Air Force and NASA; is that correct?

Admiral RABORN. Yes, sir, we are very pleased with the interchange and spirit of cooperation. I have an Air Force major on my staff, and I have a commander on the Air Force Ballistic Missile Division in Inglewood, and similarly in Army participation.

Mr. ANFUSO. Do you ever discuss special projects? For example, do you ever get together and say, for instance, the Polaris is the best thing that this country can put out, and let's all get together on something similar to this and maybe not go so far ahead with the other programs?

Admiral RABORN. I haven't been able to get my sales talk up to that high level yet, sir.

Mr. ANFUSO. OK. Thank you.

Admiral HAYWARD. He does pretty well.

The CHAIRMAN. Mr. Wolf.

Mr. WOLF. Of either admiral may I ask if this Polaris missile launching submarine has a capability of being used as an antimissile missile launcher, or can the Polaris, or a modification of the Polaris, be used as an antimissile missile?

Admiral HAYWARD. Well, let me say we are looking at the problem. It is only in the study phase. The ASW problem, as this system succeeds, we have the problem in our country that Mr. Anfuso says the Russians will have, we have to be able to defend against the Russian system. We don't have any solution to it now. We are not going to be able to just say that we sighted the submarine or we sank it after the missiles have left. We have to see if we can do something about it. We have no solution to it.

The ideal combination in a ballistic missile would be if you could use it for both defensive and offensive purposes, but this is purely a dream. We have no answer as of now, but we are looking at the problem.

Mr. WOLF. The thing that develops the question is the Bomarc program which has been so extensively discussed. I am wondering again when they are operational they are still out in the open, they have to be exposed, and this would give you the same thing in an antimissile missile.

Admiral RABORN. Perhaps just a statement on this, sir, without getting into classified matters. Some of our studies clearly show that

an antimissile missile certainly has a lot of earmarks of the solid propellant Polaris.

Admiral HAYWARD. We feel there are definite hopes in it, but I would not say publicly that we have any system. We are just studying the problem, looking at it, and if we can do it, we will certainly do it.

Mr. WOLF. Looking at the whole picture now, Admiral, and not just in the narrow field of the Navy, but rather looking at the whole national defense picture, are you satisfied with the amount of money that you have to work with on this program? Do you think you are getting your share of funds in relation to the capability of this weapon? Now, there is a nice, loaded question for you.

Admiral RABORN. I would like to answer it this way, sir: I believe if I did say I was satisfied, I would be the first man who had responsibility for a large development program who would make that admission. In other words, what I am saying is that when you have a tremendous responsibility, you invariably want to protect your ability to do that job to the maximum. However, we have to recognize—and I certainly do—that the Navy has many other problems which they have to fund for, besides the Polaris program. And because of this I can say categorically for the job which I have been given to do and the numbers that I have been given to do and the time schedule that I have to do it, that my program is adequately funded. It is a close, conservative budget, but that is the way I want to play it. I don't want to tie up a lot of dough that the rest of the Navy needs.

The CHAIRMAN. Mr. Van Pelt.

Mr. VAN PELT. No questions.

The CHAIRMAN. Mr. Moeller.

Mr. MOELLER. No questions.

The CHAIRMAN. Mr. Daddario, I think I have called on you.

Mr. Chenoweth.

Mr. CHENOWETH. I just wanted to congratulate you, Admiral, on a splendid presentation. Just one question which you perhaps don't want to answer in open session: a comparison of our submarine program with Russia's. Maybe you have touched on that previously.

Admiral HAYWARD. We have touched upon it with the Congress, but not in open session. We would be delighted to give the committee, Mr. Chairman, this information in closed session.

The CHAIRMAN. At a later date we may have an executive session.

Mr. Bass.

Mr. BASS. No questions.

The CHAIRMAN. Mr. Riehlman.

Mr. RIEHLMAN. No questions, Mr. Chairman.

The CHAIRMAN. Admiral, we want to thank you for coming here, and Admiral Hayward and the rest of your staff. I think the committee has already expressed themselves fully on how they feel about the Navy and their program. We are happy to have you.

Admiral RABORN. Thank you, sir, I appreciate this opportunity, knowing your great interest in the program, to be here.

The CHAIRMAN. It certainly helps us here on the Hill.

Admiral RABORN. I would like to introduce the man directly responsible for the Polaris program in our shop, a fine scientist in uniform, Comdr. R. O. Middleton.

The CHAIRMAN. I want the record to show that he is here and his background and record in the Navy and his contribution to this country.

Mr. FULTON. May I join in complimenting the gentleman.

The CHAIRMAN. Now, if we can quickly get settled here, we will have Dr. McRae and propound the questions we have of the Doctor, and then finish, perhaps, before the bell.

Doctor, we are sorry to have kept you waiting so long, but we will proceed quickly to ask you some questions. Would you state for background in the record some of your experience and training and service with the United States?

STATEMENT OF DR. JAMES W. McRAE, VICE PRESIDENT, AMERICAN TELEPHONE & TELEGRAPH CO., AND MEMBER, DEPARTMENT OF DEFENSE BALLISTIC MISSILES SCIENTIFIC ADVISORY COMMITTEE

Dr. McRAE. This is in the biographical material which I submitted. You would like me to repeat that briefly, I take it?

The CHAIRMAN. Yes, briefly.

Dr. McRAE. I got a Ph.D. in electrical engineering at Cal Tech and then went to work for Bell Telephone Laboratories. I worked for Bell Telephone Laboratories until 1942, when I was volunteered into the Army, and after the war went back to Bell Labs, became a vice president in charge of part of the development activities there, and then became president of Sandia Corp. in Albuquerque, N. Mex., which helps design atomic weapons, and then came back this last year to A.T. & T.

With respect to Government activities, I joined the present committee when it was an Air Force committee headed by John von Neumann, the famous mathematician and scientist of Princeton. This was the committee, as you know, that established the ICBM as a key program and put it in high gear. I joined the committee in 1955, about a year or two after they had gotten started in 1955. Then this committee was changed to a DOD committee.

The CHAIRMAN. Now, as a member of the original committee that established the status of the ICBM as a needed weapon and vehicle, what would you say, in reference to the Atlas program, the ICBM, and especially the recent failures that we have experienced?

Dr. McRAE. I probably look at the failures in ways more nearly like Admiral Raborn does than perhaps you folks did before you heard the testimony. My own opinion is that the program on all of the missiles, the ICBM's and IRBM's, has gone amazingly well and much better than we thought it would go when we originally recommended high priority action.

The CHAIRMAN. Do you think these failures that you have read about in the press and also heard about officially set our program back to any extent?

Dr. McRAE. No, sir.

The CHAIRMAN. You think we are right on schedule in spite of that?

Dr. McRAE. You realize, when you state schedules, 4 years ago for a program that would normally take 8 or 10 years to do, you are taking considerable chances, and it is very difficult to be sure whether

the program will be completed this month or next month or the month thereafter.

I think the program is within 3 months, let us say, 3 or 4 months, of the optimistic guesses we made then.

The CHAIRMAN. Now in that connection, have we lost leadership to the Russians, in your judgment? Are the Russians going further ahead of us, or what is the status there, really?

Dr. MCRAE. It is really very difficult to know what the Russians are doing. They are not free with information at all. They don't even conduct tests at places where people can take pictures of them. The net result is one must base the answer to that question on a lot of judgment, and I would guess that they have been having their troubles, too, and that we are just about in the same position. We have not lost ground.

The CHAIRMAN. From what you say, we then have not gained any ground, in spite of our redoubled efforts?

Dr. MCRAE. Oh, no, sir. I meant that we have not lost ground beyond what we expected we would have after we started this expedited program.

The CHAIRMAN. What I refer to is this: We have not gained any on the Russians, either?

Dr. MCRAE. We certainly have gained. We are doing programs here in remarkably short periods of time.

The CHAIRMAN. You think we have gained on the Russians?

Dr. MCRAE. I do.

The CHAIRMAN. For instance, in the development of the booster, you think we have gained on them? They were way ahead of us at one time?

Dr. MCRAE. We have made up some of the difference.

The CHAIRMAN. How much would you say, percentagewise, we have made up?

Mr. MCRAE. It is hard to tell—50 percent, perhaps.

The CHAIRMAN. Now, what about guidance systems? Are our guidance system still superior to the Russian's, as far as you know?

Dr. MCRAE. From my own knowledge, I can't answer that question except to say that our guidance systems have performed better than we expected they would. That is, I am saying that I do not know what the Russian's guidance systems really do.

The CHAIRMAN. In your position here with the Scientific Advisory Committee, do you check into the reasons for the failures in the firing of the missiles and then do you take any action? Or does your committee take any action in trying to assist in eliminating the cause of these failures?

Dr. MCRAE. Where that is indicated; yes.

The CHAIRMAN. What have you done?

Dr. MCREA. Well, in most of the cases, the effort that is applied to these problems immediately upon their occurrence is so very great that by the time we look at it it is a question of making suggestions as to slightly different approaches or changes in attack, and we have always found in each of the cases in which we have looked into these that the efforts were being applied in generally the same way as we would recommend them to be applied.

The CHAIRMAN. In other words, the departments are going ahead and proceeding just as you would recommend in most cases. That

eliminates most of the responsibility from your committee, doesn't it?

Dr. McRae. In what sense, sir?

The Chairman. Well, it——

Dr. McRae. It makes our responsibility easier to carry through, sir.

The Chairman. Mr. Sisk.

Mr. Sisk. I just briefly read your statement, Doctor, and it seems to me that it is a very optimistic statement. There are only two comments I have to make. I notice one statement in which you say, "to date I would say that the ballistic missile test program, taken as a whole, should instill a feeling of confidence rather than doubt that success will be achieved."

That, in essence, sums up your feeling. Now, the other significant thing that I note in your statement is that due to the fact so-called partial failures have not been due to specific design deficiencies, rather than what might be failures of various things, would lead you to feel that it would be unwise to make any change or drastic alteration in test programs. As I say, that is a very optimistic statement, and I am very happy to hear it. Sometimes we hear statements going in the other direction. I appreciate these statements, Doctor.

Dr. McRae. Could I make a brief comment, Mr. Chairman, because I think this point is very important. Why is it that I sound more optimistic? Perhaps it is because I am not looking at each test as a kind of baseball game where somebody is going to win and somebody is going to lose. This is a tendency that we all have—to look at any of these events as black or white events. Instead, those of us who are close to the program are looking at them in terms of the kind of information that Admiral Raborn told you about this morning, and General Schriever yesterday. Even the poorest tests provide information; I mean, even the ones that look poorest to the spectator often provide the most information.

Mr. Sisk. That is a very good statement, Mr. Chairman.

That is all.

The Chairman. Mr. Fulton, any questions?

Mr. Fulton. With respect to a possible change of policy, on the various components of these missiles: First, is there work being done on the standardization of components so that once tested out on one type they can be used interchangeably on another?

Dr. McRae. I believe that the present state is rather more the state in which different components are being frequently used in order that there will be more assurance of success; that is, if one fails, you will be able to use the other. We have not yet reached the time when significant standardization measures among missiles are a matter of first importance.

Mr. Fulton. That is the reason I am bringing the question up. Should we now begin looking for a standardization of proved components so that they are interchangeable between missiles, and the ones that are not operating satisfactorily on proved components then be eliminated?

Dr. McRae. I don't think, yet. I don't think we have enough information yet on the various components.

Mr. Fulton. The second problem is this: We are talking of operational capabilities of the overall missile configuration generally,

rather than the operation capabilities of the various components. My question is this: Why shouldn't we have a time on the various components—say the jetevators or the verniers, or the tankage, or the various components of guidance or, for example, on the hydraulic systems that release, or on the electrical systems or electronic systems? Why don't we have a time when those components must be made to function or the contractor at fault shall then be penalized? For example, on these experiments that the Air Force has had, one was a hydraulic failure on ground equipment, another was electrical system failure, another was failure to shut off a liquid oxygen valve. On that type of failure, that has nothing to do with experimental failure and is a component failure just like a component in a proved aircraft failing. During World War II, I served on the aircraft scheduling units, scheduling plane production for the U.S. Air Force. I was the Navy representative on that. Our problem there was to find out where the bugs were on a lot of this equipment and standardize it and come up with the basics so that we could get them done and move on then to new models.

Now, you see, if that same principle were applied here, we come to the point where when we hear that somebody failed to close an oxygen valve so that the feeding system isn't working, or that the hydraulic system on a ground operation is not in perfect working order, or that the electrical equipment—there is a short or a loose connection—haven't we come to the point where we can say to the contractor, "If you don't come up to a higher standard on that you are going to get penalized, you are going to have to put up a bond on it"; are we there yet?

So many of these failures look to me as if they are just plumbing and electrical wiring failures.

Dr. McRae. That is not an easy question to answer, as I presume you understand.

Mr. Fulton. You could put that into the record later.

The Chairman. Any further questions?

Mr. Miller. Mr. Chairman.

The Chairman. Mr. Miller.

Mr. Miller. I just want to say this to Dr. McRae: How long have we been in the missile business now—about 12 years?

Dr. McRae. Well, we have been in the missile business, I suspect, since 1946 or so.

Mr. Miller. 13 years. Now, at the end of the 13th year after the Wright brothers made their historic flight at Kitty Hawk, which would mark the kickoff of the airplane business in this country, how much further are we now on the missile than we were in 1916 on the airplane?

Dr. McRae. First, you have to be a little more precise in what you mean about missiles. We have some solid propellant operational missiles in use, and have for quite a long time. These are air defense missiles, but you are speaking of ballistic missiles. You are speaking about intercontinental and IRBM's. Well, the fact of the matter is that we did not put emphasis on these missiles until—what was it—1953 or 1954?

Mr. Miller. 6 or 7 years?

Dr. McRae. Yes. We were making a logical decision: Until you could see the payload, until you could get small H-bomb warheads, there was no sense developing a missile to carry a small payload. So we made this logical decision, not having faith that we would come to small warheads as soon as we did.

Mr. Miller. The thing is, we have made more progress in this field, as a whole, than we made in the field of the development of the airplane or the automobile or the telephone, or anything else in the same comparable age group?

Dr. McRae. Much more, sir.

Mr. Miller. The telephone or the wireless or the automobile or the airplane—when they were 13 years old, they were still in short pants compared to where we are now.

Dr. McRae. I certainly agree.

Mr. Miller. So we haven't anything to be ashamed of. I think if we quit thinking of where the Russians are and try to get down to brass tacks and see what we can do and get our job done, we still be better off. That is my own feeling.

Dr. McRae. I agree thoroughly.

The Chairman. Mr. Anfuso.

Mr. Anfuso. I just have one question, Doctor. We are very fortunate to have a man of your background and experience here. I would like to ask your opinion as to what you think of putting the Polaris missile on cruisers.

Dr. McRae. I suspect that this comes under the general philosophy that the best kind of a deterrent is not only one that is difficult to locate, but it is also difficult to determine just where and how it will come. Therefore, you should, I think, look toward having your deterrent missiles on every vehicle and every location in the most variety of situations you could imagine. Therefore, as a general principle, yes, on cruisers.

Mr. Anfuso. Thank you very much.

The Chairman. Doctor, may I ask you one question?

Dr. Herbert F. York, on July 18, made an address. In that address he said—

We have gotten somewhat frantic about catching up with the Russians. Most of our failures have been due to somebody taking a gamble, not being able to think things through, or trying to save a month or two, taking a chance that something would work.

What would you say about that statement? Do you think that is correct, that we are frantic?

Dr. McRae. I don't think so, myself. I believe the chances that are being taken are sensible ones, and I think these failures would occur no matter if you took a longer time in between each test.

The Chairman. Just like the bugs in a new airplane; you have got to use them and iron them out gradually; is that it?

Dr. McRae. That is right. Everybody knows that the automobile is a practical gadget. Yet the one I bought a couple of years ago had to have an expensive change in the rear end because it wasn't built right.

The Chairman. One more question. Your committee has charge of intercontinental ballistic missiles. Does your committee include in that vehicles, too; for instance, space vehicles?

Dr. McRae. No, sir.

The Chairman. That is not under your jurisdiction?

Dr. McRae. Only insofar as they are in the Department of Defense, which makes them really only the military ones.

The Chairman. Well, the Atlas is a space vehicle, too.

Dr. McRae. We look at it from a military point of view.

The Chairman. If there are no further questions, thank you very much, Doctor, for coming here. We appreciate it.

(The statements of Admiral Raborn and Dr. McRae are as follows:)

Statement of Rear Adm. W. F. Raborn, USN Director, Special Projects

At the very outset, I should like to express, in behalf of the entire group working on the fleet ballistic missile program, that we welcome this opportunity to provide this committee with the full facts on the status of the Polaris missile.

My purpose is to supply within security restrictions the picture as it stands today, and the prospects for integrating the fleet ballistic missile into the nuclear powered submarine on the schedules that have been set.

If classified details are required I am prepared to present that material in closed session.

We stand ready at any time to provide all Members of the Congress and the general public, too, with a documented, realistic appraisal of where this program stands.

A few remarks now regarding the importance of the FBM system. I consider that this weapon system is one that our Nation has to have to deter any possible enemy from starting—or even to consider the start of—a general (total) war. The Polaris weapon system is unique in that it combines the mobility and relative invulnerability of the nuclear powered submarine with an IRBM to give our Nation, in effect, a worldwide ballistic missile capability yet subject only to U.S. control. It will always give us the ability to react in event of missile attack on our Nation—we have time for mature decisions. It is one weapon system that the United States has to have—it needs others, too. I am happy to report that we will have this system in 1960.

Now for a little information on the fleet ballistic missile system with specific reference to Polaris the missile:

As you know, it is a complete weapons system package development program requiring development and production of the Polaris missiles, nuclear-powered submarines, submarine tenders, shore supporting activities, and industrial base, all carefully integrated to move forward in step with each other. As one example, the Polaris missile development schedule is keyed to meet the first submarine in 1960. As weapons system manager, it is my responsibility to keep these component parts moving in parallel development with later joining to form an effective FBM system which is unique among all ballistic missiles. Your interest today is primarily in our missile, Polaris. It is a two-stage, solid-fueled missile. The missile had to be small, light, and compact because of space and weight considerations in a submarine—and a submarine load of Polaris missiles is 16. For reason of safety, the decision was made to use solid fuel. Shelf life, safety, and maintenance are other key considerations, since they will be submarine borne for months at a time. The missile itself must remain dependable to withstand the effects of rough seas and salt water. It must be built to allow access to its parts for checking and preventive maintenance in the confined areas available on ships.

At the very beginning of this Polaris program we called in from industry and from our various technical laboratories the best qualified people to deal with all phases and all major components of this new ballistic missile weapons system. For the missile, problems of prime consideration were development of high-energy propellant, satisfactory motor cases using light material, missile directional control, precise motor cutoff, guidance and reentry—all to fit within a small missile for submarine use. During a concentrated study of more than 3 months' duration, we forecast the technical state of art some 5 years in advance for each of the various parts of the missile to bring clearly into focus all technical objectives so that at the end of the development period we would have the most modern and up-to-date missile that would be possible. As a result, our development test program got off to a good start and has kept on

schedule throughout its duration. We have not had to change—and have not changed—any basic parameter of our system since we completed—and implemented—the study I previously referred to some 2½ years ago.

Before discussing specific points let me state that we have made excellent if not outstanding progress in meeting the objectives planned within the accelerated time scale. Here in simplest terms is the way our technical staff and advisers have rated the 33 flight tests we have made. This is the significant score to date. Of the 33 launchings of test vehicles, 24, or slightly better than 2 out of 3, were completely successful in that all specific technical objectives were accomplished.

Seven of the 33 were rated partial successes in that 1 or more of the primary technical objectives were achieved.

Two launchings were failures. None of the primary objectives were achieved. We learned from these failures but the information was far less than we hoped to obtain. These failures, incidentally, were due to malfunctioning of relatively minor and simple elements. We wish they had not happened. They might have been prevented. They have not reoccurred.

Today my main remarks will relate to four basic points which I believe to be of greatest interest to the members of this committee in assembling the facts on our missile development.

First, where do we stand in relation to our scheduled development timetable? I am happy to be able to say that we are meeting our most recent accelerated schedule of "target dates" and that we can confidently predict that there will be operational Polaris submarines with missiles available for deployment at sea by the end of next year. In 1960 the operational fleet ballistic missile weapons system will be an element in our structure of defense.

Second, to report the technical status of the missile system as such, to provide our honest answer to the all-important question: "Will it work?"

On this point, we have every reason to be confident that we will have tested dependable Polaris missiles, have them assembled and ready when the first specially designed submarine is ready to receive them, so that the final phase of the total test program can be devoted to operational factors of the entire weapon system rather than to validating the performance of the missile as such.

Third, to identify and clarify the nature and scope of the missile development test program to date.

Despite what impressions there may be to the contrary, no operational type Polaris missiles have yet been fired. No such missiles are scheduled to be fired until sometime in the future. What we have fired in this program have been various configurations of flight test vehicles to gain information on various missile components in a flight environment and to determine the compatability of the missile subsystems. I will cover this in more detail later.

Fourth, and finally, to tell you what we have learned from these tests, what we expect from the balance of this development program, and what we plan to do between now and the departure of the fleet ballastic missile submarines to their assigned stations of operational deployment.

In regard to the timetable of this program, it is important to recognize that the basic "target date" of the entire program, the delivery of the first operational missiles and submarines to the fleet, has been accelerated by about 3 years since the fleet ballistic missile program was authorized less than 3 years ago.

Specially, this date was advanced from 1963 to about 1960. These accelerations were made possible by the substantial progress in systems development, coupled with a few major technical breakthroughs. Had not our development program been so successfully productive, it would not have been possible to respond to requests for our best possible schedule.

We have had two major breakthroughs during the missile development, one contributed by the AEC and the other a Navy achievement in the field of solid propellent fuels. The tests to date have provided verification of basic design decisions, but further substantiation is necessary to fulfill our reliability requirements for a seaborne missile. We have had no serious setback of a technical nature in terms of the basic design of the missile systems, and no situations calling for major redesign of any prime component. We have obtained a feedback of information on the types of necessary adjustments we expected to find out through these tests, and I am happy that they are becoming known to us in the early stages of our present flight test vehicle program so that solution can be tested and proved well in advance of our 1960 target operational date. I repeat, we have uncovered no situations calling for changes beyond the engi-

neering refinements normally expected in developing any new and complex mechanical, chemical, and electronic device. We require no further breakthroughs.

Let me describe our missile development program for you.

This program can be divided generally into two major areas: static and ground tests of all descriptions, and flight tests. In the static test program, various components of the missile are separately tested in many configurations. Data is taken and analyzed with the aim of improving the next model of the component. As favorably tested configurations of components are obtained, the components are put together in increasing numbers and finally we have a complete portion of the missile. This larger component, in turn, is statically tested with variations to obtain the most optimum combinations. When we have gained all of the information feasible with ground tests or static tests, we then conduct flight tests to prove out the conclusions reached from the static tests and to carry the components into the actual environment in which they will be required to operate. The flight test provides the crucial environment in which the vehicle and all of its components must be made to operate satisfactorily in order that we may have a fully acceptable bird for shipboard use. Because these flight test programs are expensive, we endeavored to utilize, in the early phases, smaller versions of flight test vehicles which were entirely adequate for the test objectives under consideration and yet are not as expensive as a full scale test model.

The Polaris development program has been carefully blocked out in major technical performance areas to develop the individual components of the missile according to a preplanned requirement. Then step by step, the type of hardware which will be most suitable for the operational type missile is ground and flight tested.

Take the warhead reentry body, which, of course, is a combined responsibility of the military and the Atomic Energy Commission. Here, a team of Navy and AEC scientists have collaborated to bring forward the warhead reentry body combination with which the Polaris will be equipped. The selection and type of materials to overcome the intense heat of reentry, shape, and type of the atomic bomb, the arming and fusing of this warhead, all are separately tested out on the ground and then the various components of the reentry body are flight tested to prove out the validity of the information gained from ground tests.

Similarly, while this is being done, the missile guidance is being put together and subjected to a whole series of tests. First, the individual components—the gyros, the accelerometers, and the stable tables are put on high speed rocket sleds at our several test stations and subjected to the rigors of high speed accelerations and the shock and vibration conditions which may exist in flight. Whirl tests on centrifuge test devices and many other tests are done on the ground on the individual components of the guidance system and finally on the completed package. At this time, the missile guidance as a whole is put into the flight test vehicle and given its preliminary flight test.

The Polaris missile has two propulsion stages; each stage has a motor. Development of these motors is a distinct feather in the Navy's cap and we're quite proud of the way that this program has progressed on schedule. Building on its years of experience in solid propellants, the Navy was bold to strike out on its own some 3 years ago seeking satisfactory solid propellant motors for the Polaris ballistic missiles.

Here the motor case, the propellant itself, the devices that control direction of the missile motors, and the thrust termination devices are checked to a considerable degree by static and ground tests before getting into the air and into space in our flight test program.

If we look at the development program of each of these components—reentry body, guidance, and the solid propellent motors—we will see that we set for ourselves certain technical goals and objectives. These objectives with the results to date may be listed as follows.

REENTRY BODY

Our objectives in this program for the first year and one-half were the development and test of components of the reentry body design. Because of space and weight considerations, we had to crowd all reentry body components into a small package and save weight in many ingenious ways. Hundreds of hours were spent in ground tests (wind tunnel, shock tests, etc.), using existing Govern-

ment and industrial facilities. Many airdrop and flight tests demonstrated the suitability of the design. Of interest is the fact that while our particular design concept was considered radical, the validity of our concept has been accepted by other activities engaged in developing ballistic missiles.

During the past year (ending July 1, 1959) it was planned to confirm basic design parameters by flight and ground tests. This has been achieved.

Remaining development work is to conduct flight tests with a dummy warhead as passenger and to obtain additional verification of the initial operational design by flight tests.

GUIDANCE SYSTEM

Objectives of this program were to design and develop the components and test them in ground and flight tests to assure meeting ballistic missile requirements. Because of the small size of the Polaris missile, an extremely small guidance package had to be devised. For the first year and one-half, a number of flight and sled tests, over 200 other environmental tests using ground facilities and innumerable circuit design and compatibility tests, have demonstrated the suitability of design and durability of the components.

Our objectives during the past year were the firming up of the hardware for the overall guidance system and furnishing of these systems for flight and ground tests and fire control checkout purposes. These objectives have been accomplished.

Work planned from now on is keyed to qualification, by flight vehicle tests and ground tests, of the guidance system for the 1960 operational missile.

PROPULSION SYSTEM

Our objectives, which were met, in the propulsion system development program for the first year and one-half were development and test of the following components and techniques:

(1) High-energy propellants for ballistic missiles application, (2) thrust termination scheme, (3) jetevators as a means of thrust vector control, (4) lightweight motor case materials, and (5) propellant and motor cases manufacturing techniques. Numerous full-scale and small-scale motors were ground tested and several vehicles were flight tested for various purposes.

During the past year, it was planned to qualify the motors for full-scale vehicle tests. The latter phase required the confirmation of reliable motors with the higher specific impulses demonstrated earlier in motor firings. Again numerous full-scale and small-scale motor ground tests and additional flight vehicle tests were conducted. A high degree of confidence in powerplant design has been achieved. Current objectives are to confirm all aspects of the powerplant design for the 1960 operational missile by flight and ground tests.

With this general outline of the Polaris missile subsystem development program for background, I would now like to take up groups of Polaris test vehicles and tell you something of the nature of the results we have obtained on which we base our assessment of progress.

The first group of flight test vehicles were especially configured to allow us to successfully develop instrumentation, telemetering, and analysis techniques while, at the same time, obtaining some information on thrust termination.

Flying the second block of flight test vehicles gave us much usable information on thrust termination. From a third group of flights, using another configuration vehicle, we obtained valuable information and confirmed many aspects of reentry body shapes, materials, and behavior.

In another block of vehicles we obtained verification of design concept for flight control components and the effects of thrust termination.

The fifth group successfully tested flight control concepts using early developmental hardware and gave us valuable environmental information on guidance system components.

By another block of test vehicles, we proved feasibility of underwater missile launching and compatibility of the missile and the launching tube. This was achieved by many successful launchings: from our pop-up facility off the California coast—including some conducted through waves generated by cruisers—from our land-based launcher, *Peashooter;* from our ship motion simulator at the Atlantic Missile Range, and from our weapon system test ship the U.S.S. *Observation Island.*

Last September, on the accelerated schedule, we commenced flight testing of the first development model of the 1960 operational missile. This flight test

vehicle incorporated for the first time in one vehicle those components developed at that point in time in the program. The previously developed systems—reentry body, powerplant, the ballistic shell, flight controls—were married so that integrated missile system flight tests could commence. We conducted captive tests at our Santa Cruz, Calif., facility of the "integrated" vehicle prior to commencement of flight tests. This gave us assurance of overall system compatibilty and operation on the ground.

Before discussing the results to date of the flight tests with this "integrated" test vehicle, let me state that this was a major sep forward and we knew and hoped that we would uncover deficiencies. We expected more problems in this phase than we had experienced in development of the missile subsystems. I knew, however, that basic design of the individual subsystems had been proven and that any problems unearthed would be susceptible to straightforward engineering solutions. I am pleased that we have uncovered no major problems to date and that we have obtained all the information we planned and more than we expected and required at this phase of the development.

To date, in "integrated" missile system test vehicle firings we have confirmed compatibility and operation of the overall system less guidance in three fully successful flights. We have achieved repeated motor stage and reentry body separations, thrust and flight control operations, reentry body operational confirmation and second stage motor ignition, and guidance system operation in a flight environment appears good. There have also been problems as we have proceeded with the flights. Some of these we consider random, others were attributable to vehicle components required only for range safety or evaluation purposes—all of the problems uncovered in the partially successful and the one unsuccessful flights of these test vehicles have been solved or solution is in sight.

The work ahead of us involves demonstration and confirmation of missile guidance control, ship motion firings from our ship motion simulator, flight tests from surface ship and submarine and proving repeatability of complete missile operational sequence. For our 1960 operational missile, we are well advanced developmentwise on lightening up structures, increasing propulsion power, and removal of a great deal of instrumentation not required for tactical missiles which is necessary for—and so heavily weighs down—our flight-test vehicles. We plan on firing the first prototype 1960 operational missile late this year.

I expect problems ahead of us but I know we can handle them. In summary, we have met or exceeded every objective as scheduled for the development program.

Against this general background of Polaris missile development test program, I will describe briefly the results of the most recent flight test conducted about 2 weeks ago, on July 15. To a casual observer, this test might be considered an apparent failure. In reality, from a point of view of getting a successful missile, it was stimulatingly successful. One of the primary purposes of the flight was to test the missile brain. Although the test vehicle went into unexpected acrobatics, the missile brain performed beautifully even under most vigorous conditions. On takeoff, this bird lost part of a jetevator—something which has never happened in any previous flight. This jetevator was recovered and is now undergoing intensive metallurgical and other tests as a basis for developing inspection procedures to prevent a recurrence. The acrobatic behavior of the test vehicle established a test condition for the missile brain we could never have planned. The ruggedness and the performance of the missile brain in this test were so outstanding that we are considering foreshortening this phase of the missile development. Since the primary objective purpose of the flight was to gain information on the adequacy of the guidance component in a flight environment, it was a most significant and helpful milestone. I have a movie of this flight which I will be happy to show you in closed session.

I do not believe that this point of flight test evaluations can be overemphasized. The success or failure of individual tests whether they be the spectacular type of tests conducted at the Atlantic Missile Range or the thousands of tests in closed laboratories must be measured in terms of contribution toward ultimate goals.

I recently read with interest the staff report of the DOD Subcommittee on Appropriations, House of Representatives, 86th Congress, titled "Reliability Efforts in Ballistic Missile Programs." In this report it was noted, and I quote:

"Managers of missile programs are required to make extremely delicate and difficult decisions in trying to achieve optimum balance between such factors as weapon capability, weapon reliability, and cost. One of their managerial re-

sponsibilities is to temper haste with caution; and a mistaken public reaction can subject them to undue pressures from outside, thus complicating critical decisions. Managers may be tempted to avoid making tests which are necessary, but which would look like failures, or to make spectacular tests of little engineering value, or to advance firing schedules for propaganda purposes."

In the Polaris program we have adhered to strict technical discipline in all of our testing, including decisions to fire the "integrated" missile flight test vehicles.

Finally, the outlook for this missile development test program is as follows:

We plan on continuing our full-scale flight test vehicle firings from Cape Canaveral and to begin live firings afloat from our weapon system test ship, the U.S.S. *Observation Island*, this year. We will continue the underwater launching test program from the ocean bottom off the California coast.

Next year, when the first Polaris submarine will be available, the first missile firing from a submerged submarine will take place.

Every step taken in the tests to date, and to be taken between now and that time, has one purpose in view. That purpose is to make certain that every component in the system will function dependably and efficiently. This purpose is to remove every possible element of uncertainty in advance.

As of today, and based on analysis of all data at hand, I feel, and state again, that we have every reason to predict success in achieving a dependable missile system by the end of next year.

Under current appropriations, nine fleet ballistic missile submarines have been authorized. Additional units, if authorized, could follow at intervals of about 1 month. The number of submarines to be built and the number of missiles to be provided for them will be determined, of course, by national policy, through its legislative and executive authorities.

Our responsibility as the development team is to design, test, and produce hardware which can be depended upon, should the need for the fleet ballistic missile weapon system ever arise, to do its job with certainty.

I am glad to be able to report that such a Polaris weapons system is clearly in sight.

STATEMENT BY DR. JAMES W. MCRAE, VICE PRESIDENT, AMERICAN TELEPHONE & TELEGRAPH CO., AND MEMBER, DEPARTMENT OF DEFENSE BALLISTIC MISSILES SCIENTIFIC ADVISORY COMMITTEE

Mr. Chairman and members of the committee, my name is James M. McRae. My occupation is vice president of the American Telephone & Telegraph Co., responsible for the defense activities of the Bell System. I appear before you today as a consultant to the Department of Defense and member of the Department of Defense Ballistic Missiles Scientific Advisory Committee—a committee appointed by the Secretary of Defense to advise and assist the Department of Defense in matters of technical policy relating to the national ballistic missiles program.

It is my understanding that this hearing is being held because of your concern about failures in recent test firings and the implications of those failures on the success of our ballistic missile and space programs. I also understand that qualified representatives of the agencies responsible for the various test programs are available to give you an analysis of the test results in each of the programs, including the specific causes of failures where these occurred and the corrective measures taken in each case. Accordingly, with your permission, I will confine my remarks to the nature of complex development programs, the reasons for having tests, the kinds of tests which are required, and the significance of the tests in establishing confidence in the final product.

The creation of an intercontinental ballistic missile system is a tremendously complex and difficult undertaking. At the outset the number of scientific and engineering problems requiring solution, although different in nature, were at least as great in number and complexity as those associated with the creation of the atomic bomb. Success could not be achieved without extending the frontiers of knowledge and technology in every major technical area: aerodynamics, propulsion, electronics, mechanics, materials, instrumentation, etc. The development of the many system elements was further complicated by the almost total lack of knowledge of the environment in which they would have to operate. The temperatures, accelerations, vibrations, noise, and radiation levels to be

encountered could only be guessed at until some experimental verification of the theoretical calculations could be provided.

For this reason, a very extensive component and subsystem test program had to be established. Initially the various components and system elements were tested individually. Later, because interactions of noncompatible elements can be critical, components were tested in assemblies and subsystems. Then the major subsystems were tested and finally the complete system must be tested. These final phases are the ones which are most spectacular and have attracted most public attention. However, they bear somewhat the same relation to the total test program that the visible part of an iceberg does to its total mass.

With respect to "failures": One must know what the test objectives are before one can classify a test as a success or failure. From a development point of view, there are very few tests which can be classed as complete failures in the sense that nothing new is learned. In fact, one frequently learns more from "failures" than from successes. To date, I would say that the ballistic missile test program taken as a whole should instill a feeling of confidence rather than of doubt that success will be achieved. I know of no complex development programs in other areas which have not encountered similar difficulties in their test phase.

I am sure that you understand that the development process is different from our usual day-to-day experience which, in this mechanical age, accepts as a normal part of our daily lives all manner of mechanical devices—from our automobiles to our television sets—without pausing to question how they came into being. Actually complex systems such as a modern bomber, normally require up to 9 or 10 years from initiation of development to introduction into service use. In the ballistic missile programs, we are attempting to combine development tests with demonstrations of performance and tests of manufacturing quality in order to shorten the leadtime to 4 or 5 years. We must not become discouraged when troubles are encountered, since one of the main purposes of a test program is to reveal these troubles and verify the corrective measures taken. As long as the failures are random, that is, not attributable to specific design deficiencies and as long as they are not a large proportion of the total number of tests, I would consider it unwise to make drastic alterations in the test programs which have been carefully planned to yield the experimental data needed to establish the performance and dependability of our advanced missile systems. Obviously, we should build on our experience as we acquire it, both from failures and successes, and refine our testing techniques which of necessity have been developed coincident with the systems to be tested.

We are entering a new technological era, an age of guided missiles, satellites, and space vehicles. We have only begun to develop the tools needed for this era. These tools include the vehicles themselves, the test ranges and instrumentation required for their development, and the reservoir of knowledge and trained personnel, materials, and components and manufacturing processes which make them possible. As these tools are refined and improved and as our experience grows, many of the problems which plague us today will be reduced to standard practice. However, I never expect to see the day when new and improved systems can be developed without encountering similar problems.

The CHAIRMAN. The committee will be adjourned until tomorrow morning at 10 o'clock.

(Whereupon, at 12:09 p.m., the committee adjourned, to reconvene at 10 a.m., Thursday, July 30, 1959, on another subject.)

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